AY-102 Recovery Project

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AREVA Federal Services, LLC

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Assistant Secretary for Environmental Management

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Office of River Protection under Contract DE-AC27-08RV14800

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Submittal for the 2017 Award for Project Excellence

AY-102 Recovery Project

Remediation of the Double-Shell Tank AY-102

Submitted by: Sebastien GUILLOT, Project Manager
Washington River Protection Solutions LLC
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**Figure 1:** Waste storage Tanks during their construction in the 200 East Tank Farms of Hanford, Washington, in the late 1960’s, and cross section of the primary Tank of AY-102. A total of 177 underground Tanks were built on the Hanford site between 1943 and 1980 to store the radioactive and chemical liquid and sludge waste generated by the production of weapon grade plutonium.
1. Introduction and Summary

Project Summary
The AY-102 Recovery Project is a critical component of the safe management of the Hanford Tank waste, and a key element of the overall Hanford site cleanup mission. Under the auspices of a settlement agreement with the State of Washington Department of Ecology (Ecology), the AY-102 Recovery project team took on the challenge of remediating an underground Tank containing radioactive chemical waste through a uniquely aggressive execution timeline, and completed ahead of schedule and under budget, the design, procurement, installation, and commissioning of a first of a kind waste retrieval and transfer system, to remove the waste from the Tank.

Context and Background
The history of the Hanford Site started in 1943 on a 586-square-mile reservation in the South East of Washington State. This military industrial site supported the cold war effort with the production of weapons grade plutonium until the 1980’s. Since 1987, the Department of Energy has re-oriented the site’s mission to focus on the cleanup and remediation of legacy hazardous and radioactive materials left within remaining facilities, including 56 million gallons of radioactive and chemical waste stored in 177 underground tanks.

Tank AY-102 is a 1 million gallon capacity Double Shell tank (DST) commissioned in 1971, with a planned service life of 40 years. The tank consists of a primary carbon-steel tank, 75 feet in diameter, inside of a secondary carbon-steel liner, which is surrounded by a reinforced concrete shell. In August 2012, the presence of waste material in the annulus space between the primary and secondary tank was detected. An ensuing investigation confirmed that the waste had entered the annulus through a leak in the primary tank bottom liner. This conclusion was officially communicated to Ecology in October 2012.

Project Scope
The Department of Energy Office of River Protection (DOE/ORP) directed Washington River Protection Solutions (WRPS), the Hanford Tank Operations Contractor, to promptly initiate recovery actions and remediate the threat caused by the potential leak of hazardous material to the environment. The AY-102 Recovery Project was commissioned in 2013 to prepare for and execute the removal and transfer of the tank waste out of the primary tank to another double shell tank for safe storage. A Settlement Agreement signed between the DOE/ORP, WRPS, and the State of Washington, established the project scope and schedule deadlines for the recovery actions. Under the terms of this legal agreement, the project team was challenged to complete this first of a kind DST waste retrieval and transfer on a very aggressive timeline of less than 36 months.

WRPS mobilized an integrated project team of subject matter experts within its Tank Retrieval and Closure department. The team successfully completed the Engineering, Procurement, Construction, and Operations of the waste retrieval and transfer system, completed a first phase of retrieval operations removing over 95% of the initial waste volume, and modified the installed retrieval and transfer system in order to prepare for the removal of the remaining waste.

Project Highlights
This document highlights the challenges of meeting the aggressive schedule milestones, and how the application of rigorous project management practices enabled the execution of a technically sound and constructible solution several months faster than the normal tank retrieval timeframe. The challenges to meet the project milestones under the scrutiny of multiple stakeholders – and most importantly – in a safe and compliant manner, was a daunting task.

The execution also required aggressive and proactive management of known and emerging project risks and opportunities, and a continuous investment in strong communication within the project team and with all stakeholders, to ensure cohesion, coordination, and a safe and timely response to all the issues encountered along the way.
2. Sponsor Letter

OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

JAN 26 2017

17-TF-0009

Ms. Lisa L. Rosenblum, Vice President of Public Relations
Columbia River Basin Chapter
Project Management Institute
P.O. Box 1781
Richland, Washington 99352

Ms. Rosenblum:

ENDORSEMENT OF THE WASHINGTON RIVER PROTECTION SOLUTIONS LLC’s
AY-102 RECOVERY PROJECT NOMINATION FOR THE PROJECT OF THE YEAR
AWARD

The U.S. Department of Energy, Tank Farms Project is pleased to endorse the subject
nomination for the Project Management Institute’s 2017 Award for Project Excellence.

The AY-102 Recovery Project is a priority to the U.S. Department of Energy (DOE), Office of
River Protection (ORP) in completing the retrieval of chemical and radioactive waste from a
leaking primary liner at a Hanford Site double shell tank. A September 2014 Settlement
Agreement between the State of Washington, Washington River Protection Solutions, LLC
(WRPS), and ORP, established both project scope and schedule deadlines for a certain set of
actions which included the engineering, procurement, installation and operations of a first-of-its-
kind double shell tank waste retrieval system in less than 36 months, within the regulatory
constraints of a nuclear safety environment.

The challenges to the AY-102 Recovery Project have been significant, including fabrication of a
one-of-a-kind retrieval system as well as performing waste removal in very challenging weather
conditions (historic cold and snow accumulation periods), all within a technically sound manner.
The solid project management tools implemented by the AY-102 Recovery Project team
included aggressive yet realistic scheduling, documentation and proactive management of project
risks, aggressively using opportunities, excellent communication with both the client and
regulatory stakeholders, and creation of a cohesive team within a contractor that is managing
multiple priorities and challenges.

The AY-102 Retrieval Project merits consideration by the Columbia River Basin Chapter of the
Project Management Institute (PMI) because the project has successfully completed the assigned
scope of work, while meeting the requirements of the Settlement Agreement. With the retrieval
of over 95% of the primary tank wastes, and successful preparations for the removal of the
remains of the wastes, the project is remediating the potential leak of materials to the
environment, and most importantly, has done all of this aggressive complex and high risk work
in a very safe manner both to the workforce and to the environment.

The AY-102 Recovery project has been recognized as one of the 2016 key accomplishments
within the Hanford Tank Operations Contract. It is for these reasons I have chosen to be a
sponsor and fully support the AY-102 Recovery Project Nomination to the PMI 2017 Award for
Project Excellence.

If you have any questions, please contact me at (509) 373-0649.

[Signature]
Christopher J. Kemp
Deputy Federal Project Director Retrieval
and Closure Project
3. Benefits/Value

Expected positive benefits/value of the project on the organization.

The AY-102 Project was mobilized on a fast track schedule to meet the expectations of Ecology and DOE/ORP, to remove the waste from the primary tank as soon as practicable, and transfer the waste to another double shell tank for safe storage in accordance with the terms of the settlement agreement. The agreement included 18 requirements with specific project deliverables and deadlines tied to financial penalties if requirements were not met. The delivery deadlines required an aggressive schedule, with minimal contingency to cover the uncertainties and risks related to a first of a kind project.

The first benefit realized by the project was to demonstrate how a deliberate and well organized team effort was able to complete challenging tasks ahead of schedule while fully complying with all the enforceable legal requirements of the settlement agreement. From project initiation through to all phases of execution, all project deliverables were accomplished safely, under budget, and ahead of schedule. This was recognized by the DOE/ORP as a key accomplishment from WRPS.

The second benefit for the organization was the opportunity to expand the pool of resources qualified to perform high risk tank farm work. When AY-102 initiated, WRPS was already engaged on an ambitious program to develop resources to execute substantial work scope including the on-going C-Farm Single Shell Tanks retrieval, and the preparation for the next decade of retrievals in the A and AX Tank farms. All available resources with relevant experience and qualification for the AY-102 Recovery project, were already mobilized to support on-going projects. Approximately 70% of the project staff was new to the Tank Farm operations, yet were trained and qualified to support the AY-102 project within a few months. As AY-102 completed its scope, the project’s staff became available to support the other waste retrieval programs.

Expected positive benefits/value of the project on society.

The project has contributed to the advancement of the Hanford cleanup mission. The risks associated with a leak to the environment from this tank have been significantly reduced by removal and transfer of the majority of the waste to another DST tank for safe storage. Completion of the project scope will further the investigation of the cause of the leak, and the assessment of the extent of conditions that could potentially initiate leaks in other tanks. These investigations and additional tank integrity inspections and monitoring will assist in the development of compensatory measures to ensure Tank Farm operations can continue under safe conditions.

Processes/tools used to verify if the expected project benefits were achieved.

The project team met all project milestones by using three project management key ingredients:

1. Define project success, with an achievable target, with concurrence of all key project stakeholders,
2. Secure project success through disciplined project planning, execution, and implementation of tracking metrics,
3. Promotion of project progress and accomplishments through regular communication with all stakeholders.

Defining a realistic target for project success and ensuring stakeholder alignment:

The configuration of Tank AY-102, an underground flat bottom tank with internal structures and obstacles, limited the type and size of retrieval equipment that could be used for retrieval. Moreover, the nature of the waste to be removed required the implementation of several remotely operated technologies that each had limited retrieval capabilities. Given these conditions, it was fundamental to characterize a realistically achievable retrieval end point that would define project success. The project team selected retrieval technologies which had been proven based on experience from the many years of past
C-farm Tank waste retrievals, with well documented capability limits, and compatible with this first of a kind application on a larger DST. This experience supported a clear definition of the limit of each technology, providing a rational basis for the end point criteria to declare retrieval completion. The project used these criterions with the concurrence of DOE/ORP and Ecology, thus providing a sound basis and achievable target for project success.

Securing successful project execution:

As further detailed in section 4 of this document, significant effort was invested in upfront detailed project execution planning. A detailed execution plan, broken down in several phases and sequenced activities, with intermediate key milestones and deliverables ensured the project team could effectively verify completion was progressing as planned. WRPS Earned Value Management System (EVMS) was used for project planning, performance measurement, and reporting. EVMS provided early and better visibility into project performance, allowing informed decisions with adequate time to implement effective corrective actions if needed.

To further secure progress under the accelerated schedule, the AY-102 project team maintained performance review processes in each execution phase. For example, design reviews were conducted to ensure compliance with system specifications. Procurement tracking and interface management between the project, buyer, and vendors was maintained to address any potential deviation (technical or cost/schedule) as soon as possible. Vendor inspections and Factory Acceptance Testing were used to verify compliance during fabrication. The Operations Readiness Verification process was started early during the construction phase to define in detail the list of deliverables required for turnover to operations, and was used as a checklist to track completion of actions and deliverables.

Risk management was key in reducing uncertainty, enabling the team to effectively communicate the major threats to stakeholders and attain their support in the mitigation strategies, and focusing the risk mitigation efforts on the most critical risk elements. The specific AY-102 Recovery risk management actions are further detailed in section 8.

Promoting project progress and accomplishments through a regular communication with all stakeholders:

Regular (daily, weekly, monthly) communication within the project team, with WRPS management, the client DOE/ORP, and key stakeholder Ecology, was critical to the success of the project. Frequent and transparent communication was absolutely key to:

- ensure all participants were aligned, coordinated, and focused on the right priorities,
- promote the project’s accomplishments,
- share the status of the leak and progress of tank monitoring activities,
- solicit feedback and ensure expectations were met, in order to build trust,
- obtain and nurture the full collaborative support of all project mission stakeholders.

Benefits-related complexities which had to be overcome.

Bridging the gap between expectations and reality:

When the project started, the team was confronted with the complexity of aligning all stakeholders to the shared vision of success and scope necessary to achieve it, within realistically achievable conditions. There were varying opinions about what was the practicable time frame to remove the waste, and expectations of an immediate response. In addition, expectations in terms of project scope, budget, and schedule, were based on the experience of prior Single Shell Tank (SST) retrieval operations, which were only partially applicable to this first of a kind DST waste retrieval operation. Significant effort was invested upfront to demonstrate, document, and convince stakeholders of why and how removing AY-102’s waste would take over $100M, 3 years and 500,000 hours of labor, and a team of up to 160 full time employees at the peak of construction activities. Retrieving 800,000 gallons of waste including 150,000 gallons of sludge from a flat bottom DST Tank, with 40 internal structures - in other words much larger and more complicated than previously retrieved tanks - had never been done before, and was going to require more equipment and tank infrastructure modifications than any previously executed tank retrieval project.

Managing the ripple effect of the insertion of a large project in an existing scope:

The AY-102 recovery project was not in contract scope, but had to be absorbed in the Tank Operations Contract scope on top of an existing and ambitious work load, and executed within the context of limited funding and resources. As a result, with stakeholder input, the company had to position this new project as its pre-eminent focus among the various competing priorities, thereby enabling successful execution.
4. Schedule

Meeting the extremely aggressive project deadlines set by the legal Settlement Agreement was by far the biggest challenge the project had to overcome. After the leak was discovered and notifications made in October 2012, WRPS issued the AY-102 Pumping Plan to communicate to the DO/ORP and Ecology a recommended roadmap for the execution of the waste removal actions. The plan provided a high level summary schedule of the proposed recovery actions with “no sooner than” completion dates, coupled with a list of project risks identified as the main opportunities for schedule impacts. Once the project was kicked-off in August 2013, proposals were prepared and negotiated with the DOE/ORP to add the AY-102 Recovery scope of work to the Tank Operations Contract. They were based on a more detailed risk analysis (further explained in section 8) which provided a basis for contingency to be included in the schedule. Based on a Monte Carlo analysis of the residual risk impacts and likelihood, and in order to reach a 50% confidence level, the proposed schedule extended the total duration of the project as initially presented in the Pumping Plan by 15 months. When the Settlement Agreement was issued to resolve the administrative order issued by Ecology, the legally enforceable deadlines set for the different key milestones of the project were based on the initial pumping plan. The agreement included a process to request deadline extension should a “good cause” be presented to Ecology by DOE/ORP and WRPS, but with no guarantee that such a request would be granted. The project was therefore challenged to accelerate execution from the start, to ensure the deadlines could be met with sufficient confidence. This meant building sufficient float on top of this best case scenario schedule, to provide contingency for the risks which would inevitably materialize.

<table>
<thead>
<tr>
<th>Scope / Milestone</th>
<th>Summary Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leak discovered in Tank AY-102</td>
<td></td>
</tr>
<tr>
<td>Tank leak remediation planning</td>
<td></td>
</tr>
<tr>
<td>Project Mobilization</td>
<td></td>
</tr>
<tr>
<td>Engineering and Design</td>
<td></td>
</tr>
<tr>
<td>Procurement</td>
<td></td>
</tr>
<tr>
<td>Construction &amp; Installation</td>
<td></td>
</tr>
<tr>
<td>Commissioning</td>
<td></td>
</tr>
<tr>
<td><strong>Ready to start waste removal by 3/4/16</strong></td>
<td></td>
</tr>
<tr>
<td>1st Phase of Operations (95% of the waste removed)</td>
<td></td>
</tr>
<tr>
<td>Waste Retrieval System Re-configuration</td>
<td></td>
</tr>
<tr>
<td><strong>Ready to start remaining waste removal by 12/31/16</strong></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7: Project timeline, summary level schedule, and principal milestones

Processes/tools used to develop and manage the schedule.

The WRPS EVMS is structured to provide integrated planning and control management covering all Tank Operations work scope, and utilizing a fixed performance baseline schedule under configuration control, and a dynamic companion working schedule used to report status and track performance. Both are project specific as identified in the Tank Operations Contract Work Breakdown Structure. The baseline schedule provides the basis for the time-phased Budgeted Cost for Work Scheduled (BCWS). The working schedule captures the basis for calculating the Budgeted Cost of Work Performed (BCWP).

The WRPS scheduling process facilitates effective planning, applying status, critical path management, and variance analysis, which are all essential tools to secure the project’s success. The schedule control system ensures that work is planned and scheduled, establishes interfaces between project participants and activities to ensure horizontal integration, and provides visibility of work progress and valid schedule information necessary to make timely management decisions. The scheduling process supports the integration of the scope, schedule, and cost objectives by documenting a logical sequence of work through the creation of relationships and interdependencies that determine total work time and the related critical path. This process ensures that the schedule supports resource planning, performance measurement, and the project objectives.

Schedules were developed and maintained by WRPS using the Primavera® software. The schedule developed to support the AY-102 Recovery project involved up to 2 full time schedulers, and compiled and logically tied over 9000 activities. Schedule development, integration, and reviews were conducted through a consistent and disciplined routine involving 7 different weekly meetings summarized as follows:

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8Primavera is a registered trademark of Primavera Technologies, Inc., 500 Oracle Parkway, Redmond Shores, California.
Two schedule development meetings focused on developing the details of the Engineering and Procurement scope of work, and the Construction, Commissioning, and Operations scope of work. The objective of this meeting was to maintain the routine of continuous schedule development and maturation, to ensure all near term activities (3 months) are fully detailed, all longer term activities are maintained and updated at a summary level, following the “rolling wave” approach to continuously improve schedule granularity and confidence.

A status update meeting was conducted to report progress on all current project activities, and to define and prioritize negative variance corrective actions or resource allocation, based on float, at the project level.

Two schedule integration meetings at the Retrieval organization and the company level, were conducted to report progress and address interface or resource conflict issues at each of these levels.

Weekly revisions of several different versions of the project schedule (all activities, 30 day look ahead, critical paths, Tank monitoring and reporting, field activities, work planning) were issued and distributed to all project participants, to maintain awareness on near term objectives, status, and priorities. Monthly reports and reviews were conducted to communicate the project status with the DOE/ORP and Ecology.

Management of the schedule’s critical path.

The schedule critical path analysis was the most important tool used by the project team to overcome the challenge of a very aggressive schedule with initially no float or contingency for risk. Once the progress status was incorporated in the project schedule, and once the schedule development meetings had been held to further develop the level of detail in the activities tracked, the weekly critical path analysis was prepared by the lead scheduler, and reviewed by the project leadership team. The critical path analysis highlighted the longest paths to each of the projects most critical milestones or deadlines (Settlement Agreement deadlines, Performance Based Incentive deadlines, and key intermediate milestones), indicating schedule variances compared to the previous week’s status. The review focused on acknowledging the impact of the latest project status (and new activities added) on the overall float, and helped focus the effort of schedule acceleration or negative variance resolution on the most critical activities. The analysis was systematically pushed beyond the primary critical paths, down to over 20 secondary critical paths with float within 20 extra days compared to the primary paths. The outcome and benefits of the critical path analysis and review were realized by:

- Identifying the most critical activities and project priorities, and sharing the information in a concise and efficient manner with the team and stakeholders to maintain awareness, focus on the right priorities, and utilize limited resources in the most efficient way,
- Providing an in depth analysis to prevent having the short sighted focus of the primary critical path only, and thus avoid the progressive buildup of a bow wave of parallel secondary critical paths eventually becoming insurmountable,
- Identifying opportunities for acceleration or schedule optimization (re-sequencing, removing some of the activities from the critical path), to build up float and contingency for risk, further securing project success.

Contribution of schedule management to the project’s success.

Schedule management was where the project team invested most of its efforts to secure project success. The upfront investment in the detailed scheduling of all project activities, and continuous and weekly optimization exercises using the critical path analysis, were key to the buildup of float, which ended up being later used to accommodate risk realizations. Overall, thanks to this disciplined and continuous effort, the project float was built up from virtually 0, to a peak of 71 days, and back down to just over 1 day when on March 3, 2016, at 2:15PM, retrieval operations finally started, bringing to a successful conclusion a very intense 24 month race to the start retrieval operations.

Schedule-related complexities which had to be overcome.

Committing to an aggressive schedule for D&D activities carrying a lot of uncertainty and risk, and needing to accelerate upfront without knowing where to focus was definitely a challenge. Even with the use of proven technology, without a minimum amount of design work, it was difficult to appreciate upfront what the retrieval and transfer system would look like, and what the extent of the Tank farms infrastructure upgrades work would have to be.

The initial schedule target was set in the pumping plan based on lessons learned and experience from similar projects, with the details and extent of the scope defined in a phased approach. Phase I of the project contract covered the design activities, immediately started up the project, and provided a more detailed and reliable basis for the balance of the scope, that is, procurements, construction, commissioning, and operations. As the scope revealed itself in more detail, the aggressive and continuous schedule development and optimization effort challenged the team to find opportunities to accelerate schedule and buildup/protect the precious project float needed for success.
5. Cost

Processes/tools used to determine the project cost.

WRPS and the AY-102 project team used a tool called “Cost Plan” to develop and maintain baseline cost estimates. The project cost estimate data includes scope descriptions, assumptions and exclusions, basis of estimate, stage of definition and methodology, legal drivers and reference documents, resource estimate detail sheets, and notes. The cost estimates are used to resource load the schedule in the Performance Measurement Baseline, which establishes the Budgeted Cost of Work Scheduled (BCWS). The BCWS is the basis for reporting performance. Cost estimates are prepared in accordance with the scope of work defined in the Work Breakdown Structure (WBS) and associated WBS dictionaries. Estimates are organized by WBS element and integrate with the baseline schedule through WBS coding, associated activity identification numbers, and resource loading of the schedule activities from the estimates. Estimates are under configuration control and any changes to the estimates are processed through baseline change management.

Budgeting is an ongoing process that begins during the cost proposal phase of the project. The project cost was initially determined and provided as a certified cost estimate per the requirements of the Federal Acquisition Regulation, as part of 2 proposals prepared to add the AY-102 Recovery project Phase 1 and later Phase 2 scope to the Tank Operations Contract (TOC). To ensure the accuracy of the cost estimate, cost estimators made extensive use of actual costs experienced from past waste retrieval projects similar in scope (C-Farm Single Shell Tanks retrievals), with input and reviews from relevant subject matter experts and control account managers involved in these projects.

The initial proposed values were updated during negotiations and ultimately finalized upon receipt of the negotiated TOC change. The Project cost Performance Measurement Baseline (PMB) consists of the budgets assigned to each of the control accounts established for each level 5 WBS element, the budget assigned to each of the summary level planning packages setup for future work, and undistributed budgets (UB). The PMB plus any applicable management reserve is equal to the Contract Budget Base.
Processes/tools used to effectively manage the project costs.

Management of the contract/project budget:
The Contract Budget Base can only be changed by contractual actions, and scope/budget can only be added to the baseline, or modified, through a rigorously controlled Baseline Change Request process. Because of the aggressive execution schedule imposed on the project, and the several months needed to prepare, review, and negotiate the contract change proposals covering Phases 1 and 2 of the project, several contract modifications were released by the DOE/ORP to enable immediate initiation and execution of the project under advanced work authorizations. While the proposals were prepared and negotiated, each contract modification extended the “Not To Exceed” (NTE) project funding limit consistent with the forecast spending rate of the project, so execution could continue without interruption. This approach added complexity and increased the number of Baseline Change Requests (BCR) needed to add scope to the project baseline in increments as opposed to once, as additional funding and budget were made available to cover more scope. Overall it took 9 contract modifications and 50 BCRs to incorporate the entire project scope and associated schedule and budget to the TOC baseline.

The cost collection system used by the project and WRPS tracks all elements of cost (labor, material, subcontracts, and other direct costs) against the different control accounts and work packages within the WBS. The basic vehicle for accumulating these costs is the charge number (CACN) that is uniquely identified to each work package. This system provides management with a means of controlling and reporting contract cost with sufficient granularity.

The project and company controls the initiation of work through a formal work and budget authorization process. This process assures that responsible organizations are specifically informed of their assigned scope of work, schedule for performance, budget for that work, and applicable charge numbers. Weekly audits were conducted by the project's cost analyst to verify the accuracy and justification of costs charged to the project, and initiate corrective actions as needed.

The project and WRPS accounting system calculates the cost and schedule EVMS performance indices, and provides input for the monthly reporting process. The process includes the analysis of cost variances, the revision of spend forecasts and estimates of projected cost at completion. When variances exceed a defined threshold, corrective actions are initiated, reviewed and tracked by management. Contract performance reports are prepared to document and communicate to WRPS management and DOE/ORP each monthly project current and projected performance status and analysis.

Contribution of cost management to the project’s success and cost-related complexities which had to be overcome

In the context of having many Tank Operations activities and projects competing for a finite amount of funding from the DOE/ORP, the disciplined management of project costs was one of the project priorities. Holding budget was critical not only to the project’s success, but also to the progress of other lower priority projects, exposed to the indirect consequences of any cost variance. Adding over $100M of scope over 3 years to an existing baseline without any extension of the funding did not occur without a significant ripple effect to other projects and company priorities. Among other TOC projects, the A/AX retrieval program was impacted and delayed because of the funding which had to be diverted towards AY-102.

Every project has a responsibility to handle their budget in a responsible manner. The AY-102 Retrieval Project had the additional pressure to preserve budget it was afforded in lieu of others, focusing significant effort toward defining and maintaining the project’s budget as accurately and rigorously as possible. This was accomplished using cost estimates based on sufficient scope definition (Phase 1 of the project), past projects experience and actual costs, and using detailed risk analysis to include risk mitigation costs upfront in the budget, helping control cost impacts by avoiding any major variance during execution.

In addition, two other key factors contributing to the project’s success in controlling costs, were the focus on maintaining schedule, and project priority within the company. Maintaining schedule, and being the number one priority ensures resources are allocated in a timely manner to execute the work, or to aggressively resolve any unforeseen condition, the perfect recipe for holding budget.

The project completed its scope with a Cost Performance Index of 1.04, and a budget underrun of $4.1M.
6. Scope

The first of many AY-102 Recovery Project challenges was to define the scope of work activities at the level of detail needed to estimate cost and establish schedule, and to include a precise and achievable target for completion. Once established, the challenge was to execute said activities within the construct of Earned Value Management. In short, the challenge was to setup a high stakes $100M project for success, starting with a scope description that could be summarized in one sentence: remove the waste from the tank as soon as possible.

Processes/tools used to document the project scope.

The project used a phased approach to gradually refine the level of detail in scope definition, and identify an achievable end point meeting the expectations of all Stakeholders.

Once the overall mission of leak remediation had been defined, a minimum amount of design work was immediately needed to better understand what the leak remediation process could be, and what the technical solution and implementation approach would look like. Until the project had initial conceptual Engineering work completed, it was impossible to provide an estimate for the Procurement, Construction and Operations pieces of the project with sufficient accuracy and reliability to be added to the Contract. The most important goal of the scoping effort was determining an achievable target for project completion, with concurrence from all key stakeholders, the client DOE/ORP, and the principal regulator Ecology. A project cannot be successful without accurately pinpointing the definition of success.

Scope definition was accomplished based on conceptual design and project preliminary planning activities, documented in the form of a high level project roadmap describing the remediation strategy. The first revision of this key document, “the AY-102 Pumping Plan”, was issued within 9 months after the Tank was declared a leaker, and recommended the retrieval and transfer of the AY-102 primary tank waste as the remediation approach.

The project execution strategy was a phased approach, each phase contracted separately, sequenced to first cover the Engineering and Design, and then (about 6 months later) the Procurement, Construction, and Operations activities. The latter phase could only be better defined once initial design was done, and the project could down select the retrieval technologies, and further define the process and equipment to be procured, installed, commissioned, and operated.

At each step of the process, and as the project roadmap matured into a detailed execution plan, the definition of project scope and project completion was documented, discussed with the DOE/ORP, and presented to Ecology, to ensure their alignment and concurrence.

Once sufficiently detailed to be added to the TOC, like all other work performed under this contract, and consistent with the WRPS Earned Value Management System, the AY-102 project recovery scope of work was organized within the framework of a product oriented hierarchical Work Breakdown Structure (WBS). The WBS subdivides the work to be accomplished within the project down to a level of detail that enables the development of an estimate and schedule of the work activities, and to assign the work to a responsible organization. The WBS dictionary is initially defined in the negotiated contract, and is written for each WBS element down to the control account level (level 5), to provide a description of the work to be accomplished. The WBS dictionary describes both the technical and cost content of each element, including any subcontracted effort, and details the scope, deliverables, requirements, assumptions and exclusions, interfaces, and completion criteria. The WBS and WBS dictionary are the two key elements of scope description and documentation within the contract proposal, and once awarded, within the project Performance Measurement Baseline.
Processes/tools used to manage the scope.
Within the WRPS EVMS, development and maintenance of the project scope is one of the responsibilities of the Control Account Manager (CAM). The AY-102 Recovery Project scope was managed by 2 CAMs with responsibility on separate elements of the scope (Engineering and Procurement; Construction Commissioning and Operations), under the authority of a Senior Project Manager. The CAMs and Project manager were assisted by a Project Controls group, in charge of the administration of the EVM system in compliance with supporting procedures.

The CAM is accountable to the project manager in all matters related to the assigned project responsibilities including defining the performance measurement baseline (scope, schedule, and budget), authorizing the work, verifying execution of the work consistent with the baseline, and managing the baseline using the Baseline Change Request (BCR) process. The BCR process is the tool used to control changes, through formal documentation to provide full visibility of the change impacts, and management review and approval. The process verifies in particular that the activities added to the Performance Measurement Baseline are included in the project scope as documented in the contract, and acts as a safeguard from uncontrolled scope creep. Changes outside of the negotiated contract scope require prior approval by the DOE/ORP through a contract change.

Contribution of scope management to the project’s success.
Scope management rigor was critical to the project’s success in many ways. The phased approach to the definition of the scope ensured that a sufficient level of detail was available when the scope was added to the contract with a cost and schedule commitment. Upfront scope maturity limited the risk of scope creep with adverse cost and schedule impacts later during project execution. Proper upfront definition of the project end point and success criteria with approval from the DOE/ORP bounded the scope within a well-defined perimeter, facilitating the detailed definition of the execution steps and activities, and documentation of the scope. The work scope was incorporated into the performance baseline in several steps, through over fifty baseline changes. The controls setup within the BCR process ensured each of these incremental changes were consistent with the negotiated scope, and funded.

Because the project was bound by a fixed execution duration with little to no schedule float, control of scope growth was critical, and the work authorization, performance tracking, and BCR processes provided the right safeguards.

Scope-related complexities which had to be overcome.
Managing the stakeholders’ different perspectives and expectations with regards to the project mission created an upfront challenge, which was overcome in the first stages of project planning by ensuring alignment of all expectations towards one common goal. This was accomplished by defining and ensuring concurrence on a project end point which was achievable with the available technologies, and by providing an end result that met the objectives of the mission: remediate the leak by removing the waste material from the Tank.

Once the end target was identified, the next biggest scope complexity was to deal with all the typical unknowns inherent to Deactivation and Decommissioning activities in old Nuclear facilities like the Hanford Tank farms. Within a project constrained mainly by a very aggressive schedule with fixed deadlines, understanding and managing all the uncertainties potentially affecting the path to the end target was critical. The phased approach in project execution and the early and in-depth risk analysis allowed for the sufficient maturation of a “conservative” scope. Risk management was critical to identify all the potential opportunities for scope change, define the potential impacts and mitigation strategies, communicate them with the client to agree on the handling strategy and clarify risk ownership. The risk response actions under the Project's responsibility were incorporated in the scope, with adequate budget, thereby again reducing the risk of unanticipated scope creep.

Figure 10: The project scope included the Design, Procurement, Installation, and Operations of a waste retrieval and transfer system to remove around 800,000 gallons of toxic and radioactive liquid and sludge waste from the leaking Tank AY-102.
7. Stakeholders

The key project stakeholders

The key AY-102 Recovery project stakeholders were all the members of the project team including subcontractors, WRPS and its management team as the contractor for the TOC, the Department of Energy Office of River Protection as client and owner of the Tank Farms, the Washington State Department of Ecology as the most critical of all regulatory bodies involved in the project’s execution, and the public and local community.

The AY-102 Recovery integrated project team (IPT) included over 160 full time employees, involved in all aspects of the project, from engineering to operations, through procurement and construction, with a key contribution of over 20 subcontractors and vendors. With the full support of the Retrieval and Closure organization, they were the key contributors to the project’s success.

WRPS and its leadership team recognized the importance of the project, and ensured the entire company was focused on providing the support the project needed to make constant progress.

The Office of River Protection of the United States Department of Energy (DOE/ORP) was the main stakeholder outside of the WRPS organization, providing contract direction, funding, and technical oversight, and holding WRPS accountable for the safe and compliant execution of the TOC.

Among the different regulating bodies (Department of Health, of Ecology, Environmental Protection Agency, Defense Nuclear Facilities Safety Board) involved in the Hanford mission, the Washington State Department of Ecology is another critical stakeholder and key permitting authority, holding the DOE/ORP and WRPS accountable to their regulatory obligations, including the specific requirements of the Settlement Agreement.

The local community and more generally the public are another stakeholder to which the DOE/ORP and the Hanford contractors are accountable for making continuous progress in the Hanford cleanup mission.

Processes and tools used to manage stakeholder expectations and communications

The first focus of the team was to align the external stakeholders’ expectations with a realistic and achievable target for project completion. This was accomplished through alignment discussions and formal agreements on the detailed definition of the project’s scope, ensuring all parties understood and concurred on how project success was defined, consistent with the experience of past retrieval project, and with the capabilities of the available retrieval technologies.

The next focus was to communicate frequently on the project objectives and accomplishments, to ensure all participants understood the execution plan, were coordinated and focused on the right priorities, and acknowledged the status of the work and progress made on all project activities. The objective was to empower each member of the project team to be successful, and maintain all other stakeholders informed in real time. This was accomplished by sharing the vision of how to reach the ambitious project goals, communicating project objectives, ensuring accountability for each project activity, providing an opportunity for open discussion and feedback, and acknowledging and promoting the progress made.

Describe how these processes/tools were used to manage stakeholder expectations and communications.

Communications with each stakeholder was conducted following a protocol, agenda, and frequency, tailored to best match each of their specific expectations, and through a number of meetings scheduled daily, weekly, or monthly.

Communication and coordination within the Integrated Project Team was ensured through active participation of all team members and key subcontractors in:

- Daily Construction and Operations “Plan of the Day” meetings or pre-job briefings, conducted to ensure team readiness for the upcoming work, real time coordination of all resources, real time issue identification and resolution, and turnover of activities conducted on multiple shifts;
- Weekly “Plan of the Week” coordination meeting on Mondays, to kick-off each week with an alignment meeting on past week accomplishments, review of the objectives and priorities, of the schedule of all important project
meetings, review of the status of all action items not tracked on the project schedule, and “big picture” look ahead on the goals for the following 3 weeks;

- Weekly status update meeting on Wednesdays, to track the progress made on all project activities, gather input to update the project schedule, and discuss corrective actions and resource allocations needed to maintain or improve schedule;

Each team meeting was concluded with a “round the room” discussion, where feedback was solicited from each participant, to acknowledge the assigned tasks, bring up any additional topic of interest to the team, and bring up any concern or need for support related to the objectives set for the day or week.

Communication and coordination with the rest of the workforce and management within the WRPS organization was ensured through the following meetings:

- Daily Plan of the Day status update and coordination meetings at the company level, to brief all entities on the status of all facilities, and planned activities for the day;
- Weekly status update and coordination meetings at the Retrieval organization or company level, to review the status of the integrated field execution schedule, focusing on resolving any organization or company level project integration issues such as interferences between activities, or resource allocation conflicts;
- Monthly updates of cost and schedule forecasts, and reviews of the project EVMS performance indicators and corrective actions;

Communication with the DOE/ORP was ensured on a regular basis at various levels. The DOE/ORP Facility representatives, the Project Controls specialist, Tank Program Manager, and the Deputy Federal Project Director for Retrieval were invited to participate in the team daily and weekly coordination meetings, to collect real time status on accomplishments and upcoming activities. A specific weekly meeting was setup to collect feedback from the Facility Representatives and discuss any issue related to conduct of operations for timely resolution. Weekly meetings lead by the Project Manager and WRPS Contract administrator were conducted with the DOE/ORP Program Manager, Deputy Federal Project Director and Contract Specialist to ensure the coordination of contract change proposal development and negotiation, and proactive resolution of project funding issues, until the contract changes covering the project scope were fully definitized.

Communication with the Washington State department of Ecology was critical to the project’s success. Ecology was one of the regulatory agencies authorizing the project’s construction and operations activities through permitting actions, and the plaintiff initiating the legal action concluded by the Settlement Agreement. The project team established and maintained Monthly project status reviews with Ecology, to coordinate permitting actions, communicate and promote the progress made towards the SA deadlines and deliverables, sharing any potential issue or risk and mitigation actions engaged in a transparent manner, and for soliciting feedback to ensure expectations were met. Monthly reports were assembled and cleared for uncontrolled release, to document the progress of the work, and make the information available to the public.

Communication with the local community and public was ensured through the release of announcements of key accomplishments in the local media, and through the regular presentations and discussions held within the public meetings of the Hanford Advisory Board.

**Contribution of an effective management of stakeholders to the project’s success.**

Expectations from all stakeholders outside of the project team to remediate the Tank leak were high, and the challenge taken up by the project team to successfully accomplish the recovery mission and meet stakeholder expectations was immense. Open and continuous communication was the principal tool used to manage expectations, build trust and confidence within the team and with all other stakeholders, and ensure full support to the project mission.

Setting and communicating realistic goals, and constantly challenging for improvement helped mobilize and motivate the workforce. Sharing with transparency the project accomplishments as well as challenges in real time with DOE/ORP and Ecology, ensured their support as a member of the team.

**Describe what stakeholder-related complexities had to be overcome.**

The project had multiple stakeholders to satisfy, each with different expectations and level of involvement. Keeping up with the ambitious project communication plan to ensure all were informed and engaged represented a big investment, but the effort paid huge dividends by building and maintaining a cohesive, highly functional, and efficient team. The full engagement of the team, extended beyond the boundaries of the WRPS retrieval organization, demonstrated its efficiency in the resolution of several crisis moments. One good example is the unprecedented quick turnaround of a permit revision, potentially holding up the start of retrieval, with key involvement and support of both the DOE/ORP and Ecology.
8. Risk

The objective of the project risk management was to maximize the likelihood of project success, by identifying the contingency plans and funding necessary to respond to the inevitable realization of project risks. Because of its high visibility, and the high expectations and scrutiny from stakeholders, the AY-102 Recovery project required success with certainty, which was not a given considering the context of its initiation, and the nature of the work to be executed. As explained in section 4, the very aggressive schedule imposed to meet critical deadlines with little to no contingency available for any risk realization. Retrieval of the AY-102 Tank was a first of a kind, and the experience and lessons learned showed that such projects carry many uncertainties and risks related to the nature of the Deactivation and Decommissioning work involved, on old facilities offering opportunities for unexpected conditions and multiple change of plans. A robust risk management strategy was therefore needed to bridge the gap between the expectation of certain success and the reality of significant uncertainty and risk.

Key project risks

The preliminary execution plan described in the AY-102 Pumping Plan mentioned 10 major risks identified as a potential threats to the timely completion of the project deliverables. Once the detailed risk analysis and mitigation process was initiated as a routine activity of the project, a total of up to 67 risks were tracked and managed in the project risk register.

Some of the principal risks which affected the course of the project, either by the significance of the mitigation actions engaged, or the potential impact of their realization, are presented in the following paragraphs:

Additional controls required to mitigate the Tank Farms chemical vapor hazards: one element of the strategy to conservatively increase vapor hazards controls was related to the level of personnel protection. Full respiratory protection became a requirement for some of the field work, with an impact on execution productivity, and additional costs for the equipment logistic support. Schedule impacts were reduced by the mobilization of additional resources, and the residual impact was absorbed by using some of the project float.

Waste retrieval activities increase leak rate in the annulus: an increased leak in the Tank annulus space represented a threat to the continuation of retrieval activities. The mitigation strategy was to include in the project scope an annulus waste pumping system which would allow retrieval operations to continue while the increased leaked was controlled. The risk materialized within 3 weeks of the start of operations, and the mitigation approach was successful, allowing for completion of retrieval without significant interruption or impact on schedule.

Insufficient technical readiness of the selected retrieval equipment: The system selected for the AY-102 retrieval included robotic sluicing canons (ERSS) which had been developed and deployed in previous C-Farm retrieval operations. Procurement of the AY-102 units had started when a similar model operated in tank C-111 failed, and revealed the need to re-visit the equipment design. Resolution of the issue suspended the procurement process for several months, and forced the project to redirect the entire execution strategy (design, procurement, installation, and operations) to include an initial configuration of the system using available spare Standard Sluicers from a previous generation, unaffected by the design issue, enabling the start of retrieval. A second system configuration would be later installed to upgrade to the new generation offering the needed additional functions to complete retrieval, once the issue was resolved. The risk handling strategy prioritized limiting the impact on schedule, and the additional scope of work and costs were added to the contract during the negotiations of the procurement, construction, and operations phase.

Radiological conditions worse than anticipated, as found conditions different than anticipated, excessive waste holdup on equipment removed: Multiple instances of unexpected field conditions affected the normal execution of the construction work. Despite the mitigation strategy consisting in planning the field work with some level of conservatism, the project estimates having lost a total of 6 to 8 weeks to resolve the unanticipated conditions.

Processes/tools used to document risks.

The first effort to identify the risks threatening the execution of the project relied on the extensive lessons learned from past Tank Farm operations or retrieval projects. Twenty-five subject matter experts carrying that valuable experience participated in a pre-mortem brainstorming session, conducted one month after kick-off of the project, and using retrospective hindsight to identify major risk which, if realized would result in the failure of the project. Failure was defined to be the inability to meet the success criteria due to lack of preparation. The team identified 78 risks, with associated handling strategies for each risk, and documented the result in what would be the initial draft of the project risk register.
Development and maintenance of the risk register, throughout execution of the project, was then conducted by constantly soliciting input from all project participants during the weekly coordination meetings, encouraging the team to continue to capture the lessons learned from past activities or other projects, and have a pro-active and critical look at all the upcoming activities. Bi-weekly risk reviews were also conducted with all the project discipline leads, to perform a detailed review and update of the register, with any new risk or opportunity identified. The updated risk register was made available to all the team members for their information and review, and documented for each risk the unique identifier, the description of the origin of the risk, the description of the consequence, the risk probability, consequence level and resulting overall risk level prior to mitigation, the owner, the mitigation actions, and the post-mitigation risk level.

A weekly risk watch list was prepared to highlight on one page the status of the project’s principal risks and mitigation actions, for the WRPS leadership team’s information. A monthly risk status report was consolidated and reviewed at the company level, to track the progress made on each project risk mitigation plan, and monitor the evolution of the risk profile. Status of the main project risks was also shared on a monthly basis with the DOE/ORP and Ecology, to maintain their awareness of the threats, and promote the on-going mitigation actions.

Processes/tools used to manage risk.

The risk management process implemented throughout the project’s execution, and reviewed during each bi-weekly risk meeting, involves the assessment, handling, and monitoring of each of the identified risks and opportunities.

As part of the assessment step, the risks and opportunities were graded as Low, Medium or High, based on the combination of their likelihood and consequence, according to criterions specific to the project and revised as often as needed. For example, the consequence level of a potential schedule impact was rated based on the status of the available project float. Grading the many risks tracked on the risk register enabled a graded management approach, optimizing the project’s efficiency by focusing the limited project resources on the most critical risks.

The handling step involved analyzing each risk or opportunity to define the best handling strategy: avoid, transfer, mitigate, or accept risk; exploit, share, enhance, or accept opportunity. Mitigation strategies were developed as early as possible for most of the project risks, and the corresponding actions were included within the project scope prior to the contract proposal, such that adequate budget and funding was secured. Part of the contract negotiation process involved review from DOE/ORP of the risk management plan, and approval of the handling strategy, in which the ownership of risks outside of the project’s control was transferred to the DOE.

The monitoring process involved the regular tracking of the status of all risk response actions, the evaluation of their efficiency on the project risk profile, communication of lessons learned and maintenance of the company risk database.

Risk management contribution to the project’s success.

By identifying and analyzing in depth all the potential threats early on, risk response actions were included in the project scope and execution plan, and budget and funding were made available to initiate these immediately. This conservative approach significantly limited the number of risks discovered later that would have adverse impact on schedule, and require the use of the company level Management Reserve.

Engaging mitigation actions early in the short project execution timeframe improved the project’s risk profile. The number of High and Medium risks were reduced from respectively 6 and 11, to 1 and 5, and the residual risks were more manageable within the context of limited time and resources.

Risk-related complexities which had to be overcome.

Risk management often involves investing in additional scope to cover the mitigation actions which have been planned to reduce the likelihood and magnitude of the anticipated potential adverse event. Within the context of limited funding available for the Tank Operations Contract scope of work, investing more money in the project to secure completion within schedule was acknowledged as the right thing to do. But it took a lot of discussion and negotiation to reach agreement with the DOE/ORP on the Handling strategy, the ownership of the different risks, and the extent of the mitigation actions to be engaged. Good communication of the risk management strategy, and upfront and continuous involvement of the DOE/ORP in the development and maintenance of the risk management plan ensured good collaboration and support from the DOE, which was key to the success of the project.
9. Project Change Management

Processes/tools used to document and approve changes.

The authorized scope, budget, and schedule for all project activities, are documented within the Performance Management Baseline (PMB), which is the reference against which cost and schedule performance is measured. Once established, the PMB is under configuration control, and revisions can only be made through the change control program, via formal Baseline Change Requests (BCR). Changes to the baseline can be external, when driven by customer directions, or internal, when driven by project or program changes.

- **External changes** are authorized by the DOE/ORP Contracting Officer, and may take the form of directed and definitized changes or directed and un-definitized changes. The former increases the negotiated contract cost as well as the contract budget base. The latter increased the contract budget base, but instead of increasing the negotiated contract cost, is placed in authorized unpriced status and may be accompanied by a Not-To-Exceed (NTE) funding limitation.

- **Internal changes** take place within the current budget and schedule limitations of the project. Examples include application of management reserve, allocation of undistributed budget, and re-planning of future efforts.

Both external and internal changes are documented through the Baseline Change Request (BCR) process. The BCR process provides a formal and standardized tracking, approval, and communication mechanism for all external and internal PMB changes. The Control Account Manager (CAM) is responsible for maintaining the baseline, including managing changes through the baseline change control process.

Processes/tools used to manage change.

Three types of BCRs were utilized by the AY-102 Recovery project to track, approve, and manage all external and internal PMB changes:

- **Administrative BCRs** were used for simple administrative changes, such as transferring of Control Account Manager stewardship, or performing clarifications and fixing errors within the PMB.

- **Advanced work authorization BCRs** were used to initiate urgent work while proposals were developed or negotiated. This type of BCR was used extensively as the project operated under NTE advanced work authorization funding from project inception in 2013, until well into fiscal 2015 when the project scope was formally incorporated into the Tank Operations Contract. This extended use of the NTE funding mechanism became the primary change-related complexity, as described below.

- **Standard BCRs** were used in all other cases, such as changing the baseline schedule, making changes to key project deliverables, adding or changing WBS elements, and modifications to resources.

Contribution of change management effectiveness in the project’s success.

The BCR process was critical to ensure any scope, cost, or schedule change was adequately controlled through proper screening, documentation, and approval. The main benefits for the project were:

- **Ensuring the Performance Management Baseline is always current.** By utilizing the BCR process, the PMB was modified in a timely fashion as project changes occurred. This is imperative as the PMB is the baseline against which current performance is measured. If the PMB is not reflective of all current cumulative project changes, then performance measurement methods (e.g. earned value analysis) will not be accurate.

- **Ensuring a robust traceability.** By utilizing the BCR process, all project PMB changes were documented, tracked, and traceable. A BCR log is maintained to keep track of the list of project BCRs, providing a good narrative of the history of the successive changes from inception to completion.

- **Ensuring customer notification and concurrence.** The project receives its authorization from DOE-ORP, and cannot contractually make PMB changes without notification or approval from DOE-ORP. This is true for both external and internal PMB changes. By definition, external changes must receive DOE/ORP Contracting Officer approval. Depending upon the type of change, internal changes require either a simple notification (e.g. baseline schedule changes, management reserve transactions), or formal approval (e.g. changes which impact contract budget base, changes which impact key project deliverables). In this way, the BCR process is a tool for both communicating changes to the customer, and obtaining and documenting his concurrence.
Change-related complexities which had to be overcome.
The most significant change-related complexity faced by the project was that for much of the project duration the project was operating under Not-To-Exceed funding limitations, while the project contract proposals was being developed and negotiated. The project was kicked-off in August 2013 with an initial direction to start under a NTE value (i.e. funding ceiling) of $2 million. By the time contract proposals had been negotiated for both phases of the project, the NTE ceiling had to be formally extended 9 times to maintain project execution without running out of funding. Operating under NTE funding for a significant portion of the project lifecycle created a whole set of administrative complexities. As the project contractually could not plan or perform work outside of its current authorization, long range planning was not allowed to go beyond what the NTE funding covered. Some activities had to be fragmented into multiple shorter activities to allow for a start as early as possible without committing budget beyond the funding limit. This scope fragmentation and incorporation into the baseline in multiple steps increased the number of changes to be processed, and increased the work of the PM, CAMs and project controls team. Overall, 50 BCRs were processed to gradually incorporate the entire project scope and associated schedule and budget to the TOC baseline.

Key changes during your project.
Beyond the multiple changes created as a byproduct of by the funding limitations, the other significant changes which impacted the project were related to the realization of major project risks.

Fiscal year 2014 started under the restricted Federal funding conditions of a continuing resolution, which impacted the Tank Operations Contract directly. The AY-102 recovery project had just been started in August 2013, and had to be temporarily suspended until full funding was finally released. During this time key project staff was re-assigned and a new Integrated Project Team had to be assembled once funding was re-established.

Requirements related to the controls implemented to protect workers from the hazards of the Hanford tank chemical vapors evolved during the project’s execution. Changes to the preventative measures, imposed more restrictive Personnel Protection Equipment and administrative controls. All work performed within the boundaries of a tank farm required, for example, more extensive air monitoring and sampling, and the use of Self Contained Breathing Apparatus. The implementation of these safety improvement measures were managed as a significant project change.

Both of these risks had been identified and documented in the project risk analysis, and the handling strategy defined in agreement with the DOE/ORP was to transfer the risk to the DOE. When these risks materialized, DOE/ORP provided contract direction to authorize changes to the Tank Operations Baseline, including the AY-102 Recovery Project baseline, in order to cover all scope, budget, and schedule impacts.

Figure 12: In a continuous effort to maintain and improve worker safety, the implementation of new hazards controls including personnel protective equipment was one of the biggest changes which affected the course of the project. Pictures show excavation work to prepare for the installation of below grade waste transfer lines, and legacy Tank equipment removal.
## Lessons Learned

### Processes/tools used to capture lessons learned.

The project implemented the WRPS Operating Experience (OPEX)/Lessons Learned Program in accordance with the U.S Department of Energy (DOE) OPEX program requirements. The program is focused on preventing the recurrence of safety and reliability events, helping avoid adverse operating incidents, and sharing good work practices among all the DOE sites to gain performance improvements and capture cost savings. To support this program, the DOE maintains an OPEXSHARE lessons learned database, as a one-stop collaborative resource to access the most current and historical operating experience information. The tool is available for use by all DOE entities (including contractors) and provides a networking platform where users can benefit from each other’s experience and institutional knowledge.

Under the leadership of a lessons learned coordinator and with the support of lessons learned subject matter experts, WRPS employees and subcontractors are expected to utilize the OPEXSHARE resource to implement lessons learned when preparing for work execution, and also to provide feedback from job performance when the development of a lessons learned is appropriate. In addition to the OPEXSHARE platform, the project also benefitted from the multiple opportunities for real time lessons learned capturing and sharing offered by the coordination and integration meetings conducted weekly at the project, retrieval organization, or company level.

The WRPS Lessons Learned procedure describes the process to be implemented to capture lessons learned, and provides detailed direction to the employees or subcontractors. The procedure includes a first screening step to identify opportunities for positive or negative work practices that could be worthy of a Lessons Learned. The next step to complete the capture process is to fully document, and submit the Lessons Learned information to the Lessons Learned coordinator for review, concurrence of appropriate managers, and publication in the OPEXSHARE database.

### Process to integrate lessons learned into the project.

Lessons learned were integrated in the project at each step of execution.

The organization setup by WRPS to execute the Tank Operations Contract scope is setup to facilitate the real time integration of lessons learned, by positioning the various projects and activities within functional or operational groups of similar scope, so that the specific expertise is shared as much as possible. The AY-102 recovery project was positioned within the Single Shell Tank Retrieval organization to benefit from the experience from similar past and on-going C-Farm retrievals, and relied on the extensive relevant expertise of the shared Engineering, Procurement, Construction, and Operations resources. This experience was used to provide a robust basis for defining the project’s scope of work and budget, establishing the leak remediation approach, selecting the technical solution and retrieval equipment, developing the execution plan, schedule, and cost estimate based on previous lessons learned.

The retrieval system design relied heavily on formal reviews from qualified and relevant Engineering Discipline Leads, Design Authorities, and other Subject Matter Experts, to make sure both the technical requirements were met, and the applicable Lessons Learned were implemented.

Subcontractors and vendors mobilized to support the project were selected based on the track record maintained by the procurement organization on their experience and lessons learned on past performance for similar scope of work.

The project developed over 130 work packages to execute all the field activities required to upgrade the Tank infrastructure and install and test the retrieval equipment. As part of the work planning process, developing the detailed work instructions includes a requirement for the work planner to review and integrate the lessons learned applicable to the work scope to be performed. The work package closure process includes a planner post execution review, to collect work execution feedback, and identify opportunities for Lessons Learned.

The project construction manager implemented hands on management of construction field work, and deployed construction leads to work directly with construction field work supervisors (FWS) on a daily basis. The construction manager and up to four construction leads at the peak of construction activities, maintained close contact with FWS to address all issues that slowed field execution. This close support to the FWS included assisting in the logistics for delivery of government furnished equipment, disposition of waste, development, release and revision to work packages, and for assuring adequate resources were assigned or redeployed as necessary to ensure field execution schedule milestones were met. Construction leads also coordinated required resources and release of work packages with the Production Operations Day Shift manager. Additionally, the contract management responsibilities usually carried by construction leads were assigned to a dedicated construction BTR with extensive construction and project management experience. This allowed the construction leads to
focus entirely on field execution. Because the project required an aggressive field execution schedule, these construction management strategies were key for meeting project schedule commitments.

The Operational Readiness process implemented by the project to ensure readiness to start Tank retrieval operations included the documentation of how Lessons Learned from previous activities had been incorporated.

**Contribution of lessons learned integration in the success of the project.**

The integration of Lessons Learned was a critical process implemented all along its execution to continuously capitalize on the successes and failures of others, to improve the reliability of the technical solution and the safety and productivity of field execution.

Lessons Learned and demonstrated past performance were used to precisely delineate an achievable scope of work implementing known technical solutions, with the support of qualified staff and subcontractors. They were used to increase the likelihood of success by providing a history of all of the potential risks to be anticipated which could adversely impact the project, and all the adequate mitigation actions to be engaged. Finally, they were used to define a budget based on actual costs, lowering the likelihood of cost overruns.

Overall, the implementation of Lessons Learned significantly increased the robustness of the execution plan, setting the project on the path to success.

**Key lessons learned and why they were key to your project and/or organization.**

Key lessons learned from past Single Shell Tanks retrieval operations were used to ensure a robust design of the AY-102 waste retrieval and transfer system, using the proven technologies of modified sluicing and high pressure water, with well documented capabilities. These capabilities were used to define reliable retrieval completion criterion, acknowledged and approved by the client and regulator, and providing an achievable target for project completion.

As part of the project’s risk management strategy, Lessons learned from difficulties related to the implementation of similar retrieval equipment were used on several occasions to adjust the course of the project, avoid the risk of being impacted by a similar upset condition, and secure completion within schedule:

- Significant hydraulic leaks were revealed in the boom extend/retract functions of both Extended Reach Sluicers (ERS) during operations of the system installed for the retrieval of the C-111 tank. Recovery actions included redesign of the ERS to change the hydraulic hoses material, and modification of select components. The corresponding lessons learned and design modifications were applied as the AY-102 ERSS units were procured, with modifications of the ongoing fabrications. Standard Sluicers were mobilized as a temporary substitute to the ERSS, so retrieval operations could start on schedule, while the ERSS were modified.
- A slurry distributor failure was experienced during the retrieval of Tank C-105, in September 2014. This event provided lessons learned on how to improve the design of the discharge nozzles, to reduce the risk of plugging the nozzles by slurry sedimentation when pumping is interrupted. The AY-102 Slurry distributor design was subsequently modified during the procurement phase to benefit from these lessons learned.

Key lessons learned from AY-102 Recovery experience were also applied to the improvement of other Tank Farm projects. They were related to process improvements to reduce the risk of worker exposure to chemical vapors or the risk of rework by lack of verification holding points, and included opportunities for improvement in the area of conduct of operations, roles and responsibilities, attention to detail and strict adherence to procedures. They all contributed to reinforcing the organization through a safer and more efficient way of doing work.