MTR 2004-17 MITRETEK TECHNICAL REPORT

Independent Evaluation of Pueblo Chemical Agent Destruction Pilot Plant (PCAPP) Process Alternatives

December 2004

(Redacted Version)

This special version of this report has been revised to omit contractor proprietary and Government pre-decisional information

Customer:	Office of the Secretary of Defense (OSD), Deputy Assistant to the Secretary of Defense (Chemical Demilitarization and Threat Reduction)	**Contract No.:**	DAAD13-01-D-0009/027
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Mitretek Project Approval: ______________________________

Abu Talib, Director,
Chemical Remediation and Demilitarization

Executive Summary

Background

The Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) will demilitarize and dispose of mustard agent-filled mortars and artillery shells stored at Pueblo Chemical Depot using a chemical reagent Neut-Bio process. The office of the Program Manager for Assembled Chemical Weapons Alternatives (PM ACWA) has been assigned the responsibility of managing the PCAPP design, construction, systemization, pilot testing, operation, and closure. The PCAPP systems contract was awarded to Bechtel National, Inc., on 22 September 2002. Bechtel has teamed with the Washington Demilitarization Company, Parsons, and Battelle Memorial Institute to form the Bechtel Pueblo Team (BPT), which is responsible for the design, construction, systemization, operation, and closure of PCAPP.

Objectives and Approach

Mitretek Systems has been tasked to analyze the current PCAPP design, and it's associated Independent Government Cost Estimate (IGCE)[1], to identify potential design changes that would reduce capital and life-cycle costs. This work is being performed for the Office of the Deputy Assistant to the Secretary of Defense (Chemical Demilitarization and Threat Reduction).

Mitretek's analysis encompasses the following:

- **Cost Drivers—**Characterization of the major features of the current design for PCAPP and identification of major cost drivers
- **Phase Schedule Durations—**Determination of the durations for systemization, operations, and closure phases of the current design and characterization of the factors that could influence the duration of each life-cycle phase
- **Staffing—**Evaluation of the proposed staffing levels for the current design
- **LCCE—**Analysis of and adjustments to the life-cycle cost estimates (LCCE) for the current design as a result of the schedule and staffing analyses
- **Identification of Alternatives—**Identification of process design features that could be modified or deleted for cost-effectiveness without considerable impact on overall destruction schedule while maintaining compliance with safety and environmental requirements
- **Recommended Process—**Evaluation of schedule and staffing requirements for the recommended alternative design configuration and their impact on plant life-cycle costs

In this report, Mitretek uses two terms to describe cost: cost-effectiveness refers to the LCCE, while affordability refers to what can reasonably be budgeted (i.e., has an executable funding profile/is "fiscally executable"). Mitretek evaluates cost-effectiveness, providing an

[1] It should be noted that this "IGCE" was the Government's life cycle cost estimate (LCCE) compiled for to be used for budgetary purposes. Not all parts of this LCCE are suitable for use as a tool for contract negotiations, but it represented the best available data.

LCCE for certain alternatives, and qualitatively addresses affordability in support of the Program Objective Memorandum (POM) build process.

Mitretek also uses two terms to determine whether a particular alternative is feasible: technically and politically. While technical and cost factors are considered *tangible*, meaning that estimates can be generated for them, affordability and political feasibility are considered *intangible*, meaning that they can only be qualitatively evaluated. An example would be offsite disposal of agent hydrolysate; equipment and facilities reductions are tangible, whereas public acceptance is considered intangible, although known public opposition makes this alternative politically infeasible.

Major Findings

Major findings are cited below. Mitretek recommends reading the remaining portions of this report for the detailed rationale of these findings.

Finding: Demilitarization Facility "Size"—For the most part, PCAPP's physical layout is appropriate for the given project objectives under which the systems contractor was operating. In addition, it is inappropriate to compare the size of PCAPP with a baseline incineration facility.

Various government agencies have noted that the size of PCAPP's main demilitarization buildings is considerably larger than any baseline incineration facility; of particular concern was the size of the Contamination Category "A" and "B" areas.

It is true that PCAPP's main demilitarization floorspace is about 3.7 times larger than baseline incineration, with PCAPP's Category "A" and "B" area floorspace about 2.6 times larger than baseline incineration. However, these are apples-to-oranges comparisons. More appropriately, PCAPP should be compared to a combination of the baseline operations: reconfiguration, reverse assembly, neutralization, and thermal treatment. In addition, different processing schemes must be considered. For example, baseline typically stores many secondary wastes in the storage depot for later processing during closure or sends them offsite for disposal, whereas PCAPP was designed to process secondary wastes onsite as they are generated. It is Mitretek's assessment that the PCAPP design has appropriate space utilization; alternatives are identified that would decrease facility size, but these are strictly a result of changing the process.

It should also be noted that "size" is not the primary construction cost driver for PCAPP destruction facilities. For the current design, processing equipment (fabrication and installation) represents about twice the cost of the buildings that houses it for the Energetics Processing Building (EPB) and Agent Processing Building (APB), and that is assuming higher cost wall construction than proposed by the systems contractor. In other words, while making the facility "smaller" decreases construction costs, removing process equipment (with an associated decrease in facility size) provides the best savings.

The current PCAPP design was driven by the following:

- *Total Solution*—All wastes to be treated onsite
- *Baseline Lessons Learned*—Design facility to deal with munition anomalies and process problems observed during the baseline incineration and neutralization projects
- *Meet the Chemical Weapons Convention (CWC) Deadline*—Complete weapons destruction by 29 April 2012
- *Design Evolution*—Changes in the design that are part of routine evolution of plant design from concept through implementation;
  ACWA's Accelerated Schedule Options that were incorporated to meet the CWC deadline (On 25 March 2002, the Under Secretary of Defense for Acquisition, Technology and Logistics directed the Army and PM ACWA to identify an approach to accelerate destruction of the chemical stockpile at Pueblo. Four Acceleration Options were considered: Revised Acquisition Strategy/Contracting approach, construction before RCRA Part B permit, streamlined processing to include enhanced reconfiguration, and off-site shipment of process and secondary wastes.)

This is not to say that the project objectives cannot be changed. It is Mitretek's assessment that some or all of the objectives can and should be changed (see the design alternatives finding below).

Finding:	**Design Alternatives—All alternatives identified are technically feasible but some are likely to be politically infeasible. Some alternatives have tangible benefits, while others are somewhat intangible, but beneficial nevertheless.**

A number of PCAPP design alternative studies have been conducted by various government agencies. Mitretek independently conducted an evaluation of potential design alternatives in an effort to make PCAPP more economically feasible. The ground rules for Mitretek's consideration were that the change improve cost-effectiveness (without unreasonable affordability), that it be feasible, both technically and politically (e.g., public acceptance, environmental permitting, etc.), and that there are no unmanageable safety issues. Many possible "alternatives" are considered routine design refinement/optimization by Mitretek and not assessed.

While costs and technical feasibility are tangible, political feasibility is intangible. Offsite disposal alternatives pose the greatest challenge. During community forums, the Pueblo community has voiced concerns about safety, loss of jobs, and sending Pueblo's wastes to other communities. Costs and benefits of off-site disposal alternatives were discussed with the Pueblo community in July 2003 as a result of an offsite disposal study (FOCIS 2003).

There are design alternatives that may make PCAPP more affordable and cost-effective. Offsite disposal of wastes typically improves both affordability and cost-effectiveness. Reduction in the processing capacity (e.g., fewer processing lines or postponing treatment) improves affordability but may worsen cost-effectiveness if it overly increases the life cycle schedule. The goal is to identify a process with less capacity that still has a net savings in the LCCE—that is, that cost increases resulting from an extended operations schedule are less than cost savings from construction and systemization schedule (closure can be a savings or loss depending on the alternative).

The operation of a 3-line facility has been examined and modeled to determine a base schedule and LCCE. The process alternative recommended by Mitretek is a 2-line process with offsite disposal of uncontaminated dunnage and uncontaminated and stable propellant. It is Mitretek's assessment that this process is more manageable and presents less programmatic risk (has a greater chance of success) than the 3-line process. It should be noted that minimizing the complexity of other portions of the facility may improve the manageability of the 3-line process. Some such alternatives, listed below, Mitretek recommends for further study:

- Offsite disposal of uncontaminated toxicological agent protective (TAP) gear (e.g., demilitarization protective ensemble [DPE])
- Offsite disposal of uncontaminated spent carbon
- Hot air decontamination of secondary wastes (e.g., DPE)

Other alternatives recommended for further consideration are listed below:

- Minimize the processing capacity for secondary wastes and buffer the excess onsite
- Process contaminated secondary waste in the MPT only, not the dunnage, shredding, and handling (DSH) line, keeping the DSH line uncontaminated
- Process surface-decontaminated ("3X" decontamination level) secondary wastes in the DSH only during a special campaign when leakers and rejects are processed in the Energetics Process Building (EPB)

Finding: Systemization Schedule—The systemization schedule is very optimistic, mostly due to the assumption that [redacted] can be completed in parallel with construction, with only [redacted] of formal systemization.

The IGCE systemization estimate includes [redacted] overlapping with construction followed by [redacted] of formal systemization. The baseline incineration average total systemization period, based on data from Tooele Chemical Agent Disposal Facility (TOCDF), Anniston Chemical Agent Disposal Facility (ANCDF), Umatilla Chemical Agent Disposal Facility (UMCDF), and Pine Bluff Chemical Agent Disposal Facility (PBCDF), is [redacted]. The PCAPP systems contractor's plan to modularly fabricate and test much of the PCAPP processing equipment offsite to reduce on-site systemization activities is innovative and aggressive, but it could prove very challenging. The initiation of on-site systemization after only [redacted] construction completion ([redacted] of construction) is deemed unrealistic due to predictable conflicts in the activities of both phases. A more realistic starting point for the initiation of systemization is at [redacted] construction completion ([redacted]). In addition, the large number of pieces of equipment, some of which have a high degree of complexity, offsets the gains resulting from offsite fabrication and testing. The Mitretek projection for the most-likely 3-line total systemization period is [redacted] —[redacted] of pre-systemization (overlapping with construction) followed by [redacted] of formal systemization. This projection is based on adjusting the average baseline systemization period by giving credit (a reduction in time) for fabrication and testing of equipment offsite and the need for only one integrated plant run for projectiles, as well as adding additional time for increased plant complexity over baseline. The Mitretek projection for the most likely 2-line systemization period is [redacted]—[redacted] of pre-systemization (overlapping with construction) followed by [redacted] of formal systemization.

Finding:	**Operations Schedule—The BPT operations schedule is optimistic, mostly due to the assumption of high availability for the PCAPP systems. The BPT and IGCE operations estimates do not include the schedule increase needed when leakers and rejects are processed at the end of operations.**

The operation of a 3-line facility has been studied and modeled to predict the operations schedule. Based on historical experience at Johnston Atoll Chemical Agent Disposal System (JACADS) and TOCDF, the normal processing rates specified by BPT are reasonable and have been demonstrated at these facilities on a sustained basis. However, BPT's estimated system availabilities were considerably higher than those typically demonstrated at JACADS and TOCDF. While Mitretek recognizes that certain systems may perform better than what has been demonstrated, it believes that BPT's availability estimates cannot be justified at this time. In general, BPT's predicted equipment availability estimates are reduced in the IGCE calculations and reduced further in the Mitretek calculations.

Mitretek's operation schedule also includes the significant effect of processing leakers/rejects on one line after all of the normal campaigns are completed. This change in the sequence of campaigns had not yet been taken into account in the BPT and IGCE estimates and is planned to address processing concerns from the Department of Defense Explosive Safety Board.

Mitretek's estimates for operations schedule durations are longer than the BPT or IGCE estimates. Durations are [redacted] for the 3-line base case (about [redacted] higher than the IGCE) and [redacted] for a 2-line case.

Finding:	**Concurrent Operations—Mitretek believes that concurrent processing of three munition types is feasible. However, there is potential for delays because of increased demand for repair/maintenance activities.**

Mitretek examined whether the facility designed for concurrent (simultaneous) processing of three types of projectiles/mortars would be feasible without adversely affecting throughputs. Proper planning, design, and staffing are needed to avoid degradation in throughput, as was sometimes seen when TOCDF processed multiple munition types. PCAPP has been designed to process in this manner from the initial design with dedicated processing lines and enhanced support systems, such as additional control-room workstations.

Mitretek believes that concurrent processing of three munition types is feasible and this scheme is utilized in all operations schedule estimates presented. However, the presence of the third line (regardless of what it is processing) would result in an increased demand for maintenance and repair activities. Because of potential conflicts and delays in personnel entries in DPE suits, a small delay time was added for times to repair systems in the EPB and APB in Mitretek's calculations of the 3-line operations schedule. This additional delay is assumed to not be needed for a 2-line facility and is not included in calculations of its operations duration.

Finding: Closure—The IGCE for closure duration is appropriate and consistent with the closure duration estimate developed by Mitretek.

The IGCE for closure is based on a [redacted] duration. Mitretek performed its independent estimate of closure duration using the results achieved at JACADS for comparison. While the PCAPP process facilities are significantly larger than JACADS and with more equipment to decontaminate, these factors are compensated for by the increased use of chemical decontamination techniques to treat areas that had only been subject to agent vapor contamination and by the redundancy in Metal Parts Treaters (MPTs) available to support thermal treatment activities during closure. After evaluating the individual increases or decreases in closure duration associated with each of the relevant factors as compared to JACADS, the Mitretek assessment also projects a duration of [redacted] for PCAPP closure of a 3-line facility. For the 2-line facility design, the utilization on only two MPTs would increase the closure duration slightly to [redacted].

Finding: Overall Schedule—The overall schedule to complete destruction of the munitions stored at Pueblo is considered to be optimistic by Mitretek; it has been adjusted to what Mitretek considers the "Most Likely" estimate.

As noted earlier, Mitretek finds the IGCE for systemization and operations durations optimistic. Based on Mitretek's schedule adjustments, the complete destruction of the munitions stockpile at Pueblo occurs [redacted] beyond the CWC treaty deadline (see Figure ES-1 on page ES-7). Pessimistic values were also determined to establish estimated ranges for schedule durations.

Finding: Staffing—In general, the IGCE staffing levels and mix are reasonable for the proposed 3-line process. With the Mitretek recommended process (2-line with off-site disposal of uncontaminated dunnage and propellant), however, considerable staff reductions are possible.

For the 3-Line process, the IGCE estimated an overall peak staffing level of [redacted] personnel, while the Mitretek overall peak staffing estimate was [redacted]. The less than [redacted] difference is primarily attributed to redundancies found in the IGCE staffing plan and small variations in staffing levels proposed by Mitretek.

The staffing estimate for the proposed Mitretek 2-Line process is approximately [redacted] lower than the staffing level proposed for the Mitretek 3-Line process. This reduction is primarily attributed to a significant reduction of Plant staff (outside area operators, maintenance personnel, instrument technicians, etc.).

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of the report}

Figure ES-1 – Summary of PCAPP Schedules

Finding: Historical Costs—Based on the IGCE, PCAPP construction costs are about [redacted] higher than the most expensive baseline incineration facility (Umatilla). Additionally, the IGCE operations peak staffing level has [redacted] more staff than the Tooele plant—the largest staffed baseline incineration facility.

These observations are primarily based on the schedule-driven, "total solution" design philosophy of PCAPP, as well as the systems requirements for the selected destruction technologies. PCAPP is a 3-line facility designed with excess capacity and backup/redundancies to increase the potential for meeting the CWC treaty schedule. The relatively higher PCAPP staff level is attributable to the fact that PCAPP has more systems to operate and maintain than baseline incineration.

Finding: Cost—The Mitretek recommended process—a 2-line PCAPP with offsite disposal of dunnage and propellant—is expected to cost about [redacted] in constant 2004 dollars (CN04$). This represents about a [redacted] decrease in total life cycle costs from the 3-line "base case" process ([redacted]).

Mitretek's cost analysis of PCAPP indicates decreases in overall life cycle costs if certain redesign efforts are carried out. After evaluating the IGCE and adjusting that estimate downward for slightly lower staff levels but upward for longer schedule durations, the Mitretek 3-line "base case" is expected to cost about [redacted] (CN04$). This is about [redacted] more than the IGCE estimate of [redacted] (CN04$). In contrast, Mitretek evaluated a smaller 2-line PCAPP that would send uncontaminated dunnage and uncontaminated, stable propellant offsite for processing. This facility is estimated to cost about [redacted] (CN04$).

Finding: Affordability—During its early life cycle, annual PCAPP spending may exceed [redacted]. With design variants, PCAPP can be made more affordable and cost-effective without sacrificing safety and environmental considerations.

The planned yearly expenditures for PCAPP construction are higher than that achieved for any of the baseline incineration facilities. During Mitretek's discussions with government agencies, concern was raised regarding the yearly expenditures and ability to budget, as well as spend, such large amounts. Although capital investment is still expected to remain high in the early years, Mitretek's analysis indicates that the 2-line process with the offsite disposal of dunnage and propellant begins to offer technical solutions for reducing costs.

Finding: Technology Certification—Increases in the LCCE of PCAPP from what was certified to Congress in 2003 are primarily due to development of the design for this emerging technology.

The current PCAPP Neut-Bio technology has changed notably since the conceptual design that was certified to Congress in 2003. Most of this is attributed to the normal evolution of an emerging technology from concept design to current intermediate design. Detailed information regarding this finding is published in a separate Mitretek report.

Recommendations

Based on these major findings, Mitretek recommends the following actions or activities:

Recommendation:	2-Line Process—The PM ACWA should focus any redesign efforts on the adoption of a 2-line process for PCAPP, with trade studies conducted to address issues regarding plant throughput enhancements.

Based on Mitretek's evaluation, the 2-line process with offsite disposal of dunnage and propellant provides a cost savings of about [redacted] (CN04$) relative to a 3-line process. A more detailed engineering evaluation needs to be performed to identify any design issues related to this process configuration. A capital cost review would be needed to determine whether additional cost reductions are possible.

Recommendation:	Cost Budget—The PM ACWA should review the statement of work for the PCAPP systems contractor to allow it to verify the effectiveness of the performance-based mechanism to track cost throughout the program, specifically addressing cost growths and ceilings.

The issue of cost growth and ceilings should be more explicitly addressed in the BPT contract. While the systems contractor has incentives to meet schedule and comply with CWC treaty requirements, currently, there appears to be no effective mechanism in place to track construction costs. BPT is subject to the Army's Earned Value Management System (EVMS), but tracking construction costs did not seem to keep pace with the design. Furthermore, performance-based requirements should be a function of the funding profile because affordability is clearly becoming an important issue that needs to be addressed and tracked accordingly.

Recommendation:	Public Outreach—The OSD and PM ACWA should actively work with the local communities and the state regulators to get their support for the offsite disposal of dunnage and propellant.

Although an environmental assessment has been performed indicating that offsite disposal of uncontaminated dunnage and of uncontaminated and stable propellant shows no significant impact (ANL 2004), it is important to actively engage the community and the regulators by discussing concerns that they may have regarding additional actions. The OSD and PM ACWA will have to discuss the costs associated with building and operating PCAPP in light of the overall DOD budget constraints; public cooperation and support will be needed to make offsite disposal a viable option.

Recommendation:	Validation and Verification of Life Cycle Costs—Due to the criticality of current budgetary issues, a rigorous, well-documented, validated life cycle cost estimate (LCCE) that garners the involvement of all participating agencies is needed.

Establishing PCAPP data quality is central to determining the confidence that can be placed in the technical and economic performance of this facility to process mustard munitions at the Pueblo Chemical Depot. At present, cost estimators are distributed among various organizations and their subcontractors (e.g., Corps of Engineers, systems contractor, Program Management Office, and program management support contractor). Data sources are disparate, and documentation tends to abound with discrepancies.

Confidence in the estimated cost savings realized from the PCAPP design variants is only as good as the quality of data used to derive the cost estimates. A more rigorous quality control of cost data is needed. The initial steps towards enhancing data quality are close coordination among various parties involved in the cost analyses and documentation of data sources and assumptions.

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1 Introduction

1.1 Background

The office of the Program Manager for Assembled Chemical Weapons Alternatives (PM ACWA) is responsible for managing the design, construction, systemization, pilot testing, operation, and closure of chemical demilitarization facilities to destroy chemical weapons stockpiles in Pueblo Chemical Depot (PCD), Colorado, and Blue Grass Army Depot, Kentucky.

The selected technology for destroying and disposing of mustard agents (HD and HT) in munitions at PCD is neutralization followed by biotreatment (Neut-Bio). On 22 September 2002, a systems contract to design, build, systemize, operate, and close the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) was awarded to Bechtel National, Inc. The scope of services were divided into three sequential phases:

Phase 1—Design, construct, systemize, and pilot test
Phase 2—Demilitarize HD and HT munitions
Phase 3—Close site

The current design for PCAPP is built around three process components:

- Accessing—Preparing materials (munition and secondary wastes) for treatment
    - Energetics: Projectile/Mortar Disassembly Machines (PMDs) followed by caustic dissolution/destruction in Energetics Rotary Hydrolyzers (ERHs)
    - Agent: Munition Washout Systems (MWSs) to drain and wash
    - Secondary Wastes: Size reduction by Dunnage Shredding & Handling (DSH)
- Treatment—Destruction of energetics and chemical agents
    - Energetics: Caustic neutralization in continuously stirred tank reactors
    - Agent: Water neutralization in continuously stirred tank reactors
    - Munition Hardware: Thermal treatment in Heated Discharge Conveyors (HDCs)
    - Munition Bodies: Thermal treatment in Metal Parts Treaters (MPTs)
    - Secondary Wastes: Thermal treatment in Continuous Steam Treaters (CSTs)
- Post-Treatment—Preparation of wastes for disposal
    - Hydrolysate: Biotreatment in Immobilized Cell Bioreactors™ (ICBs)

The design calls for three PMDs housed in separate explosion containment rooms (ECRs); thus, in this report, this design is called the "3-line" or "base case" process. Details on the facility layout are provided in §2, *Alternatives*, on page 13 of this report.

On 30 January 2003, pursuant to §142 of Public Law 105-261, the Strom Thurmond National Defense Authorization Act for Fiscal Year (FY) 1999, the Office of the Secretary of Defense (OSD) certified to Congress that "*the implementation of pilot-scale testing of accelerated neutralization (hydrolysis) followed by biotreatment at the Pueblo Chemical Depot is as safe and cost-effective for disposal of assembled chemical munitions as incineration, and is capable of* *completing the destruction of such munitions on or before the date by which the destruction of the munitions would be completed were incineration used."*

Between January and March 2004, OSD conducted an evaluation of design alternatives for the current PCAPP design to ensure affordability and cost/schedule effectiveness (AoA 2004). The results of the evaluation indicate that the currently designed PCAPP is going to cost considerably more than the Pueblo plant conceptual design (the "fast path"[1]) that served as the basis for the January 2003 certification to Congress. This evaluation found that design variants may exist and may reduce construction and life cycle costs (LCCs) with minimal impact to schedule. An excerpt of a directive from the Office of the Assistant Secretary for Nuclear, Biological, and Chemical Defense Programs (Dr. Dale Klein) to PM ACWA is provided below:

> *"As a result of the review of the PCAPP evaluation of design alternatives (CAIG's review), there are alternatives to the systems contractor's current design. These alternatives can decrease the LCC for the PCAPP facility by reducing the design footprint and the number of personnel required for operations while maintaining safety standards and schedule. Therefore, request you pursue a revised design concept conforming to these findings, and issue a new task order under the PCAPP contract to perform the necessary analyses in support of this effort.*
>
> *Affordability must be a more important consideration during the planning, programming, budgeting, and execution of this project. Consistent with the prior Department certification required by Public Law 105-261, the current contract should be modified to ensure there is an effective incentive to maintain the total cost of this project within the Acquisition Program Baseline objective cost. It is imperative that you develop an executable funding profile, consistent with the above direction, in support of the FY06-11 Program Objective Memorandum (POM) build. This information is to be provided to the Deputy Assistant to the Secretary of Defense (Chemical Demilitarization and Threat Reduction) by May 31, 2004, for validation of POM submittal."*

In the light of these developments, Mitretek Systems has been tasked to perform an independent evaluation of the potential PCAPP design variants. In performing this evaluation, Mitretek reports directly to Mr. Patrick Wakefield, Deputy Assistant to the Secretary of Defense (Chemical Demilitarization and Threat Reduction). This report documents Mitretek's evaluation of the current design and associated life-cycle cost estimates (LCCEs) in accordance with the objective stated below.

1.1.1 Study Objectives

The main objective of this study is to independently assess the current design and LCCE for PCAPP (based on the intermediate design for a 3-line process) and identify potential design alternatives that would reduce construction and life-cycle costs.

[1] The "fast path" was a selected combination of the Neut/Bio and Neut/SCWO technologies to create a conceptual process considered to have the lowest programmatic and technical risk.

The objective of Mitretek's task is threefold:

- Provide a real-time independent evaluation of the progress of Bechtel's design effort for the Pueblo facility
- Conduct a technical assessment of any new design
- Develop an independent assessment of the safety, cost, and schedule associated with any new design

In addition, Mitretek assessed the need for an evaluation of PCAPP design alternatives based on their affordability, LCCs, schedule, and consistency with the OSD's certification to Congress that it would be as cost-effective and as safe as an incineration technology and would also destroy the weapons as efficiently as an incinerator.

This task is divided into three phases, which are discussed below. This report represents the product of Phase 1; Phases 2 and 3 are follow-on tasks. For each phase, Mitretek will submit its findings to the Deputy Assistant to the Secretary of Defense for Chemical Demilitarization and Threat Reduction in support of programmatic decisions, such as the Program Objective Memorandum (POM) build process. As needed, Mitretek will also brief the members of a committee from the National Research Council (NRC), who are also providing independent assessments of the Chemical Demilitarization Program.

Phase 1—Independent Verification of PCAPP Design Variants

Mitretek is independently assessing the May 2004 Bechtel design (PCAPP Intermediate Design Package [IDP]) and associated Government LCCE to identify feasible PCAPP design variants that will ensure affordability and cost- and schedule-effectiveness.

Phase 2—Independent Assessment of PCAPP Design Variants

Mitretek will independently assess the design variants and cost data for any new PCAPP design as it evolves. Mitretek will review and evaluate the technical assumptions and cost data used by Bechtel Pueblo Team (BPT) and PM ACWA for the revised LCCE and schedule projections for the PCAPP design variants.

Phase 3—Independent Assessment of BGCAPP Design

Mitretek will assess the current BGCAPP design concept and LCCE to help determine whether an Assessment of Alternatives (AoA) is necessary. Mitretek's recommendation will be based on technical assessments, an affordability assessment, and an assessment of the LCC and schedule estimates using the 30 July 2004 BGCAPP initial design as the basis of the assessment.

1.2 Approach and Assumptions

1.2.1 Approach

Figure 1-1 on page 10 illustrates Mitretek's study approach. The first part of the analysis involved design verification. This includes understanding the design features and plant layout;

examining the basis for the estimated schedule duration for plant systemization, operations, and closure; and examining the number and skills mix of the systems contractor staff during systemization, operations, and closure. Labor costs were recalculated as a result of schedule and staffing analyses. The revised LCCE, reflecting the new schedule and staffing estimates, represents the Mitretek "base case".

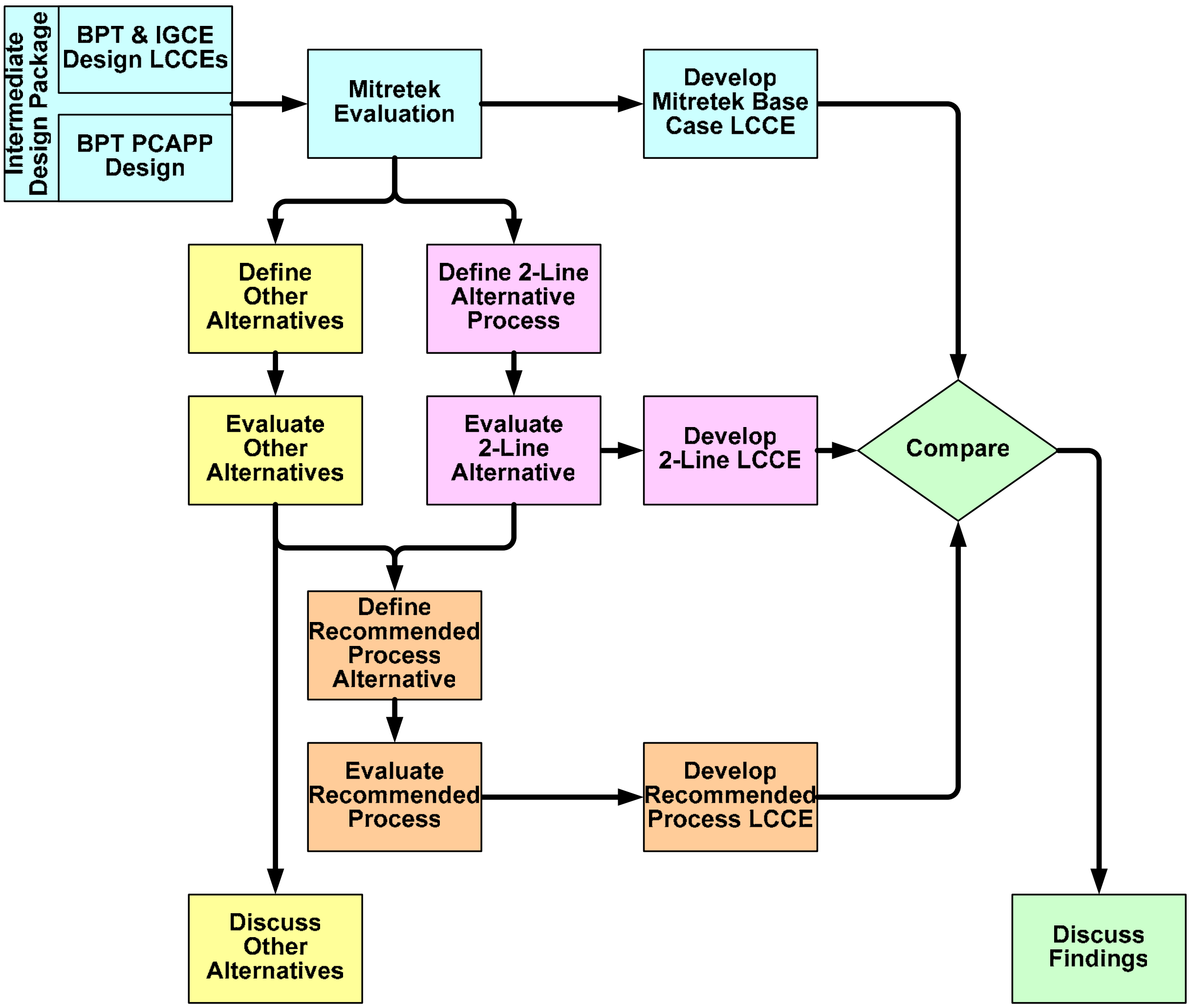

Figure 1-1 – Mitretek Study Approach

The second part of the analysis involved the evaluation of a Mitretek 2-line process alternative, as well as other alternatives—including offsite disposal alternatives—and other potential waste treatment and disposal strategies.

From the analysis of alternatives, Mitretek developed a recommended alternative process that encompasses various design features deemed to be technically, economically, and politically feasible. Cost factors associated with this configuration and their impact on the overall schedule for destruction of the munitions inventory at the PCD was then determined. The affordability and cost-effectiveness of this new configuration as compared to the 3-line base case is judged in terms of annual expenditures (capital and operating costs) and overall LCCs. The cost analysis is presented in Section 5 of this report.

In this report, Mitretek uses two terms to describe cost: cost-effectiveness refers to the LCCE, while affordability refers to what can reasonably be budgeted (i.e., has an executable funding profile/is "fiscally executable"). Mitretek evaluates cost-effectiveness, providing an LCCE for certain alternatives, and qualitatively addresses affordability in support of the Program Objective Memorandum (POM) build process.

Mitretek also uses two terms to determine whether a particular alternative is feasible: technically and politically. While technical and cost factors are considered *tangible*, meaning that estimates can be generated for them, affordability and political feasibility are considered *intangible*, meaning that they can only be qualitatively evaluated. An example would be offsite disposal of agent hydrolysate; equipment and facilities reductions are tangible, whereas public acceptance is considered intangible, although known public opposition makes this alternative politically infeasible.

1.2.2 Assumptions and Data

The study assumptions are discussed below.

The construction schedule of [redacted] for the 3-line process—as indicated in the Independent Government Cost Estimate (IGCE)[1]—is used in the Mitretek study. Mitretek did not evaluate the construction schedule estimate of the 3-line process or the assumptions behind the development of the schedule and deferred to the judgment and expertise of the U.S. Army Corps of Engineers (USACE), who are actively involved in the review and oversight of construction-related activities for PCAPP. Mitretek did, however, analyze and estimate the construction schedule for the 2-line process.

The annual distribution of Military Construction (MILCON) funds for construction costs, developed by the USACE Engineering and Support Center, Huntsville (USACE-HNC), is used as-is; Mitretek did not verify the assumptions and calculations. The same is true for the Research, Development, Testing, and Evaluation (RDT&E) funds. As such, Mitretek did not develop a formal spend plan for PCAPP. The overall cost analysis in this report is based on a pattern of expenditure outlays as presented in the Independent Government Cost Estimate. Estimated construction cost changes focus primarily on direct costs associated with both MILCON and RDT&E funds. The cost to complete the 3-line design or any additional redesign costs associated with implementation of potential alternatives are not included in Mitretek's evaluation.

[1] It should be noted that this "IGCE" was the Government's LCCE compiled for to be used for budgetary purposes. Not all parts of this LCCE are suitable for use as a tool for contract negotiations, but it represented the best available data.

For the 3-line process, the IGCE for field non-manual staffing, other direct costs, and indirect costs for construction are used as-is; Mitretek did not verify the assumptions and calculations. For the 2-line process, Mitretek did evaluate the systems contractor staffing during construction.

The schedule and staffing analyses of the 3-line process (Mitretek base case) focus primarily on systemization, operations, and closure phases.

Major data sources for this study are listed below:

- **Process**: PCAPP Intermediate Design (3-line Process), May 2004 (PCAPP IDP)
- **Offsite Disposal Alternatives**: *Analysis of Impacts of Off-Site Disposal Options for the Pueblo Chemical Agent Destruction Pilot Plant (PCAPP)*, prepared for the Program Manager for Assembled Chemical Weapons Alternatives (PM ACWA) by FOCIS Associates, Inc., 25 July 2003 (FOCIS 2003)
- **Life Cycle Cost Estimates**: IGCEs from January 2004 through June 2004

1.3 Report Organization

Section 2 provides the assessment of the alternatives. It includes the approach, the method of selection, and alternatives that Mitretek endorses; other alternatives evaluated are included in §0 on page 138. An overview of the PCAPP 3-line "base case" process as defined in the PCAPP Intermediate Design is also provided.

Sections 3, 4, and 5 evaluate the schedule, staffing, cost, respectively, for the 3-Line "base case" process, a Mitretek 2-line process, and a 2-line process with offsite disposal of dunnage and propellant.

2 Alternatives

This section presents Mitretek's systematic look at the 3-line base case and at the various alternatives to it. Alternatives include equipment and facility changes, as well as processing strategies; the related impact on construction, schedule, and staffing costs are discussed in later sections.

2.1 Approach

2.1.1 Selection of Alternatives

Mitretek used a previous analysis of alternatives (AoA 2004) as well as its own assessment to identify prospective alternatives, and then used its engineering judgment to reduce this to candidate alternatives for evaluation. In general, Mitretek attempted to identify areas where change would provide the most benefit. A number of PCAPP alternative studies have been conducted by various government agencies. Mitretek independently conducted an evaluation of potential design alternatives in an effort to make PCAPP more economically feasible.

The ground rules for Mitretek's consideration were that the change improves cost-effectiveness (without making affordability unreasonable) and that it be feasible, both technically and politically (e.g., public acceptance, permitting, etc.). For this study, processing alternatives must indicate a notable benefit associated with cost and/or schedule. It is Mitretek's position that true alternatives do not include common improvements that should be part of routine design development and optimization, such as tank or minor room resizing, materials of construction changes, minor subsystem equipment changes or elimination, etc. Although such changes on a combined may dramatically improve the LCCE, Mitretek considers these routine, expected process refinements and optimizations. An alternative should be a dramatic change in operating or processing philosophy, methodology, technology, or approach that represents a significant benefit, not just different.

While costs and technical feasibility are somewhat cost-tangible, political feasibility is cost-intangible. Offsite disposal alternatives pose the greatest challenge. During community forums, the Pueblo community has voiced concerns about safety, loss of jobs, and sending Pueblo's wastes to other communities, as well as outright opposition of certain alternatives. It is not known to what extent the costs and benefits of off-site disposal alternatives have been discussed with the Pueblo community.

It should be noted that there are many things that "could" be done, but careful assessment reveals that few of these actually provide notable benefit. Mitretek avoided changes for the sake of change and identifies only changes providing considerable potential value-added, either tangible or intangible.

For example, some adjustments could make the facility "smaller," but they would only end up moving rooms out of the facility into detached, standalone facilities that typically cost more per square foot. For example, the Life Support System (LSS), which provides breathing air for Demilitarization Protective Ensemble (DPE) entries, does not have to be part of the Energetics Processing Building (EPB)—it is not at some chemical disposal facilities (CDFs). However, historical experience indicates that integrating the EPB with the processing facilities could eliminate problems experienced with this system being located some distance away in the Utility Building (UB).

It should also be noted that “size” is not the primary construction cost driver for PCAPP destruction facilities. For the current design, processing equipment (fabrication and installation) represents about twice the cost of the buildings that houses it for the Energetics Processing Building (EPB)[1] and Agent Processing Building (APB) as shown in Table 2-1 below, and that is assuming higher cost wall construction than proposed by the systems contractor. In other words, although making the facility “smaller” decreases construction costs, removing process equipment (with an associated decrease in facility size) provides the best savings.

Table 2-1 – Relationship of MCD and RDTE Costs for EPB/APB

Source: IGCE 2004 Project Time & Cost Spreadsheets (PT&C 2004-09)

	Cost ($M)	
Facility	**MCD**	**RDTE**
EPB	[redacted]	[redacted]
APB	[redacted]	[redacted]
Total	[redacted]	[redacted]
RDTE = [redacted] *MCD*		

Offsite disposal of wastes typically improves cost-effectiveness and affordability. Reduction in the processing capacity (e.g., fewer processing lines or postponing treatment) improves affordability but may worsen cost-effectiveness if it overly increases the life cycle schedule. In this instance, cost increases due to extended operations schedule are greater than cost savings realized from shorter construction and systemization schedule durations (closure can be a savings or loss depending on the alternative).

In addition, it is difficult to know the operations impact to plant capacity when eliminating processing equipment. The PCAPP process appropriately incorporates a “spares” philosophy—backups for large and small critical pieces of equipment and a certain level of extra capacity. To some extent, this is also based on lessons learned from baseline. Mitretek did not attempt to delete these features from the design. This can only be accomplished through simulation and modeling (throughput and mass, material, and energy balances). These various types of modeling capabilities reside mainly with BPT, although Mitretek developed its own throughput model to complement results of the BPT throughput model. As such, Mitretek can only do a high-level engineering estimate of the impacts—any proposed alternative will have to be appropriately validated by a detailed design assessment. For example, a straight percentage “off the top” is not very accurate in most cases, but it is the best method available for the purposes of this assessment. Mitretek attempted to account for such factors as redundancy, backups, and shared unit operations. For example, when removing one of three unit operations, the cost may only

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[1] The EPB includes the corridor between the Control Support Building (CSB), the EPB, and APB (CEA)

have been reduced by [redacted] rather than [redacted] to account for common or shared features of the three units.

2.1.2 Exclusions, Cost-Intangible Factors, and Inclusions

Exclusions

Certain features of PCAPP, like other CDFs, will have little if any change regardless of the alternatives. This can be attributed to a number of reasons, but primarily because it does not represent a significant cost (base case or alternatives), it is project-specific (needed regardless of process design), and/or the alternatives change only the staffing, not the facility. These features include the following:

- Operations-Related
  - Control & Support Building (CSB) and CSB Filter Area (CFA)
  - Laboratory (LAB) and Lab Filter Area (LFA)
- Utilities
  - Electrical Substation
  - Main Electrical Building (MEB)
  - Natural Gas Distribution
  - Pump House
  - Sewage Disposal
  - Standby Diesel Generators (SDG)
  - Utility Building (UB)
  - Water Wells
  - Dedicated utilities for non-process facilities
- Ancillary
  - 2 Entry Control Facilities (ECF)
  - Gasmask Supply Building (GSB)
  - Maintenance Building (MB)
  - Personnel Maintenance Building (PMB)
  - Personnel Support Building (PSB)
  - Warehouse (Outside Fence) (WOF)

Intangible Factors

Certain “intangible costs” cannot be factored into the LCCE such as:

- Safety
- Environmental Permitting and Compliance
- Utilities
- Offsite Disposal Factors (transportation and disposal facilities)
- Socioeconomic Factors
- Public Outreach Factors

These “intangible” factors, shown in Table 2-2 below, are thoroughly discussed in the *Offsite Disposal Options* report (FOCIS 2003); for the most part, they are unlikely to change. These factors will be further acknowledged in this report when such factors pose a significant problem.

Table 2-2 – Description of Intangible Cost Factors

Factor	Description of “Intangible” Costs
Technical Issues	Major technical issues and challenges associated with each option relative to the base case. Quantitative assessments of the technical issues are reflected in the report’s life cycle costs and schedules.
Safety	Impact of each option on worker and public safety relative to the base case. Worker safety addresses the inherent hazard characteristics of each option and the controls required to mitigate the hazards to acceptable levels. Public safety addresses the potential impacts to the public from normal plant operations and during upset conditions, including the potential impact to the public as a result of the accidental release of materials from the plant.
Environment Permitting and Compliance	Impact on the NEPA process (environmental impact statement [EIS] and record of decision [ROD]) and environmental permitting and compliance requirements (Resource Conservation and Recovery Act [RCRA], Clean Air Act [CAA]). Cost and schedule impacts related to permitting and compliance are included in the report’s respective cost and schedule factors.
Transportation	Potential impacts on traffic volume, traffic accidents, and overall transportation risks of each option relative to the base case. The information used to assess transportation risk will be obtained from the Transportation Risk Analysis recently completed for PM ACWA by Argonne National Laboratory.
Water Consumption	Quantitative impacts of each option relative to the base case on water consumption.
Power Consumption	Quantitative impacts of each option relative to the base case on power consumption.
Treatment, Storage, and Disposal Facility (TSDF)	TSDF availability and capacity to handle each of the additional wastes being shipped.
Treaty	Treaty inspection and oversight requirements of each option relative to the base case. Any increases or decreases in costs associated with Treaty compliance are factored into the report’s cost analysis.

Source: (FOCIS 2003)

Basic Inclusions

The facilities that change due to the alternatives are the demilitarization process-related facilities:

- Energetics Processing Building (EPB)
- Agent Processing Building (APB)
- Process Auxiliary Building (PAB)
- Waste Storage Building (WSB) (for offsite disposal alternatives only)
- Demilitarization Filter Area (DFA)

- Post-Neutralization
  - Biotreatment Area (BTA)
  - Brine Reduction Area (BRA)
  - Water Recover Area (WRA)

Method of Assessment

The alternatives presented in the following section include a description of the alternative (and differences from the 3-line base case) and the pros and cons of the alternative.

The effect of these alternatives on the LCCE—including construction, staffing, and schedule—are provided in later sections of this report. LCCEs are not provided for all alternatives; for example, known intense public opposition makes some alternatives politically infeasible. These are discussed purely for completeness and to document Mitretek's assessment. Some of the alternatives have too many uncertainties related to their technical feasibility for Mitretek to evaluate or endorse at this time. However, recommendations are made for studies to further examine those alternatives with the potential to have substantial cost improvements.

Discussions of Alternatives

The 3-line "base case" is discussed first, along with basic adjustments or suggested studies. A detailed process flow diagram (PFD) and facility layout is provided for reference.

For each alternative, a brief description of the process and significant impacts of the changes are provided. Where appropriate, each description also includes flow diagrams and facility layouts with summary changes tabulated.

2.2 3-Line "Base Case" Process

This section provides a brief overview of the PCAPP site, the primary demilitarization facilities, and the process based on the PCAPP intermediate design (PCAPP IDP). It is provided for reference only to supplement an understanding of PCAPP and is not intended to be a replacement for the design package. In the event of discrepancies or ambiguity, the design package takes precedence.

2.2.1 Process Description

The process description is in the form of flow diagrams. For detailed textual descriptions, the intermediate design should be consulted. The flow diagrams in this section are organized—from top to bottom—by the type of operation that is being conducted. The unit operations are categorized into four distinct areas:

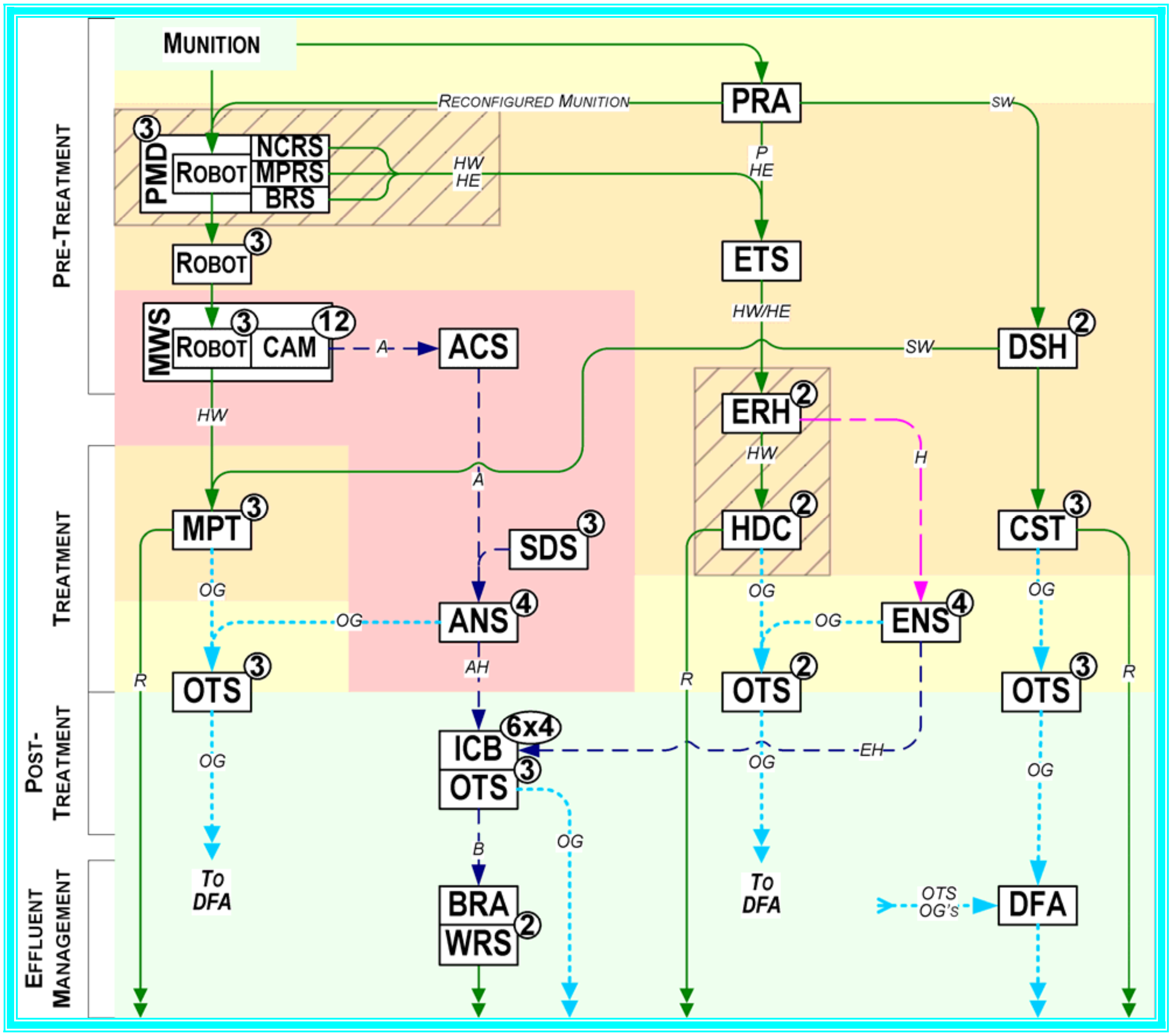
- **Pre-Treatment**. These operations prepare and reconfigure feeds and materials for the treatment technologies. Manual preparation, such as unpacking, feeding, and most of projectile reconfiguration, precedes all operations. Pre-treatment technologies usually involve gaining access to the internal chemical fills but also involve preparing feed for treatment, such as material segregation, size reduction, and chemical or thermal pre-treatments.

- **Treatment**. These operations detoxify chemical agents and deactivate explosive materials.
  - Thermal. Treatment using heat by initiating a reaction under high-temperature conditions. The heat alone can and does destroy the chemicals, but the reactive environment inside the furnace defines the reaction products.
  - Chemical. Treatment using a chemical reagent by mixing liquids, slurries, or solids with a reagent (consisting of one or more chemicals) in a reactor.
- **Post-Treatment**. These operations change the chemical nature of waste streams from treatment to remove any remaining hazardous characteristics.
- **Effluent Management**. These operations change the physical nature of streams from post-treatment to allow final disposition.

For reference, flow diagrams of the 3-Line "base case" are provided. Figure 2-1 on page 19 is a simplified block flow diagram (BFD), with major process equipment shown by its respective acronym, defined in Table 2-3 on page 20, which also includes a legend (see also the Glossary on page 109). Figure 2-4 on page 24 is a detailed PFD that attempts to provide a detailed representation of the PCAPP equipment and material streams. The BFDs have the same general layout, from top to bottom, as the PFD. The PFD provides useful details for each block on the simple BFD here and as provided later for each alternative. These drawings are intended to supplement the BFDs also used in §2, *Alternatives*, on page 13.

2.2.2 Site Layout

PCAPP site layouts are shown in Figure 2-2 on page 22 and Figure 2-3 on page 23. Table 2-4 on page 21 describes the acronyms used in these drawings. Unlike the single MDB for baseline facilities, the main demilitarization buildings for PCAPP consist of the EPB, the APB, the CSB, and the CSB/EPB/APB (CEA) corridors that connect the three facilities.



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP)
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-1 – 3-Line "Base Case" Block Flow Diagram

Table 2-3 – Block Flow Diagram Acronym Descriptions & Legend

CATEGORY "A" CATEGORY "B" CATEGORY "C" CATEGORY "D" ECR (#)NUMBER OF UNITS

SOLID LIQUID SLURRY GAS RELEASED (#) CHANGES TO NUMBER OF UNITS (<) REDUCTION IN EQUIPMENT SIZE/CAPACITY

Acronym	Definition
Streams	
A	Agent
B	Brine
E	Energetics
H	Hydrolysate
HE	High Explosives
HW	Hardware
OG	Offgas
R	Residue (agent free)
SW	Secondary Waste (Dunnage, DPE, etc.)
P	Propellant
Pre-Treatment	
- Accessing	
ACS	Agent Collection System
DSH	Dunnage Shredding & Handling
MWS	Munitions Washout System CAM – Chemical Access Machine (munition specific)
PMD	Baseline Projectile/Mortar Disassembly NCRS – Nose Closure Removal Station MPRS – Miscellaneous Parts Removal Station BRS – Burster Removal Station
PRA	Projectile (Artillery & Mortar) Reconfiguration Area (Baseline Reconfiguration)
ETS	Energetics Transfer System
- Dissolution	
ERH	Energetics Rotary Hydrolyzer
Treatment	
ANS	Agent Neutralization System
ENS	Energetics Neutralization System
HDC	Heated Discharge Conveyor
MPT	Metal Parts Treater
SDS	Spent Decontamination System
Post-Treatment	
ICB	Immobilized Cell Bioreactor
OTS	Offgas Treatment System
Effluent Management	
DFA	Demilitarization Filter Area (Carbon Filtration)
WRS	Water Recovery System

Table 2-4 – Acronym Descriptions for Site Layouts

Drawing Acronym	Definition	Description
AHU	Air Handling Unit	HVAC heating/cooling building air supply system
APB	Agent Processing Building	Agent accessing (fluid washing) and treatment (neutralization and thermal treatment)
BEB	Biotreatment Electrical Building	Electrical distribution/control for the BTA
BTA	Biotreater Area	Biotreatment system, including ICBs and auxiliary equipment
CEA	Corridor CSB/EPB/APB	The corridors between the CSB, EPB, and APB including tray transfer and personnel access
CFA	Control Support Building Filter Area	Carbon filter banks to supply filtered air to the Category E CSB
CSB	Control Support Building	Site operations control, including the EPB and APB Control Room (CON), and DPE support area (DSA)
DFA	Demilitarization Filter Area	Carbon filter banks and monitoring houses for the EPB and APB
ECF	Entry Control Facility	Site physical security entry control
EPB	Energetics Processing Building	Energetics accessing (reverse assembly) and treatment (neutralization/thermal treatment); Dunnage accessing (size reduction) and treatment (thermal treatment)
FEB	Filter Electrical Building	Electrical distribution/control for the DFA
GSB	Gasmask Supply Building	Site gasmask supply
ICB	Immobilized Cell Bioreactors	Circulated, packed-bed, biodegradation unit
LAB	Laboratory	Site monitoring and analytical lab
LFA	Laboratory Filter Area	Carbon filtration for Laboratory hoods
MAV	Modified Ammunition Van	Munition transportation truck
MB	Maintenance Building	Maintenance related activities
MEB	Main Electrical Building	Site electrical distribution and control
PAB	Process Auxiliary Building	EPB and APB supply system (water, steam, compressed air, bulk chemicals, etc.)
PMB	Personnel and Maintenance Building	Employee support area (locker area, lunch room, medical services, etc.)
PSB	Personnel Support Building	Offices for systems contractor and government personnel
SDG	Standby Diesel Generator	Standalone, generators for site emergency power
UB	Utility Building	Site utilities and distribution (steam, compressed air, electrical)
UPA	Unpack Area	Portion of the EPB used for munition receiving, pallet breakdown, and process line feeding
WOF	Warehouse Outside Fence	Storage area for spare parts and shipping lay down area
WSB	Waste Storage Building	Staging area for waste to be sent offsite for disposal
XFMR	Transformer	Electrical transformers

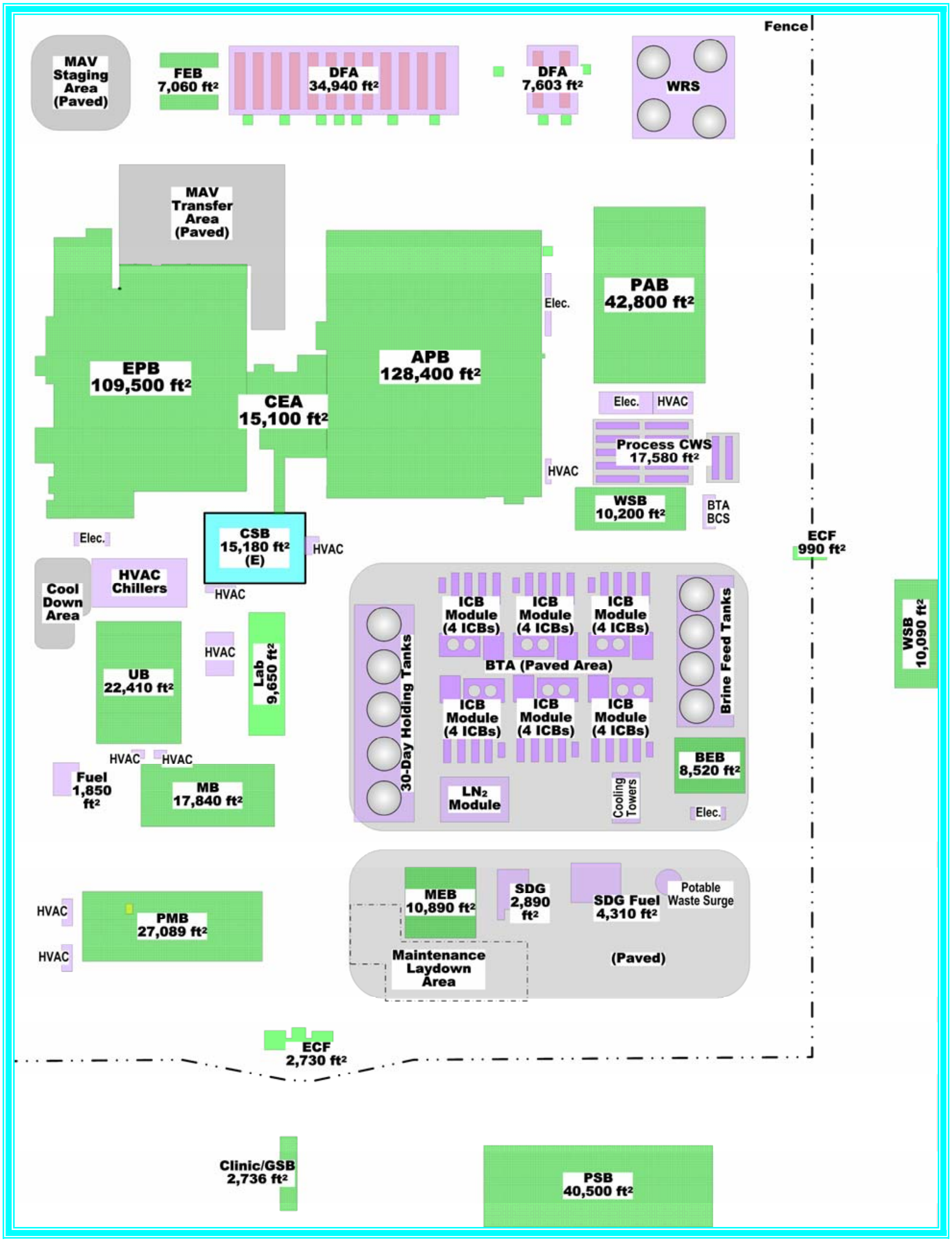


Figure 2-2 – PCAPP Site Layout (Intermediate Design)

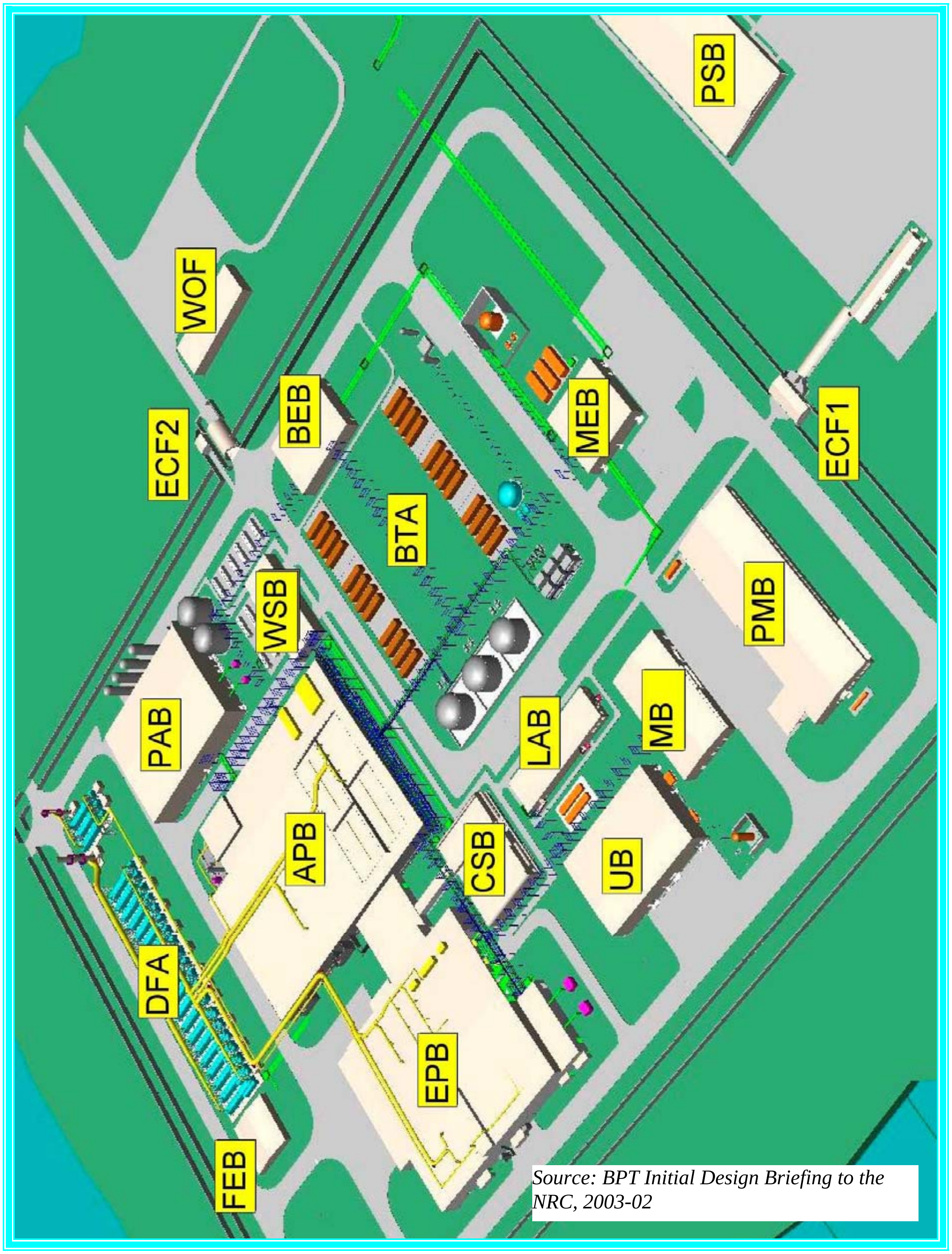


Figure 2-3 – 3D Graphic Layout of PCAPP (for visualization only)

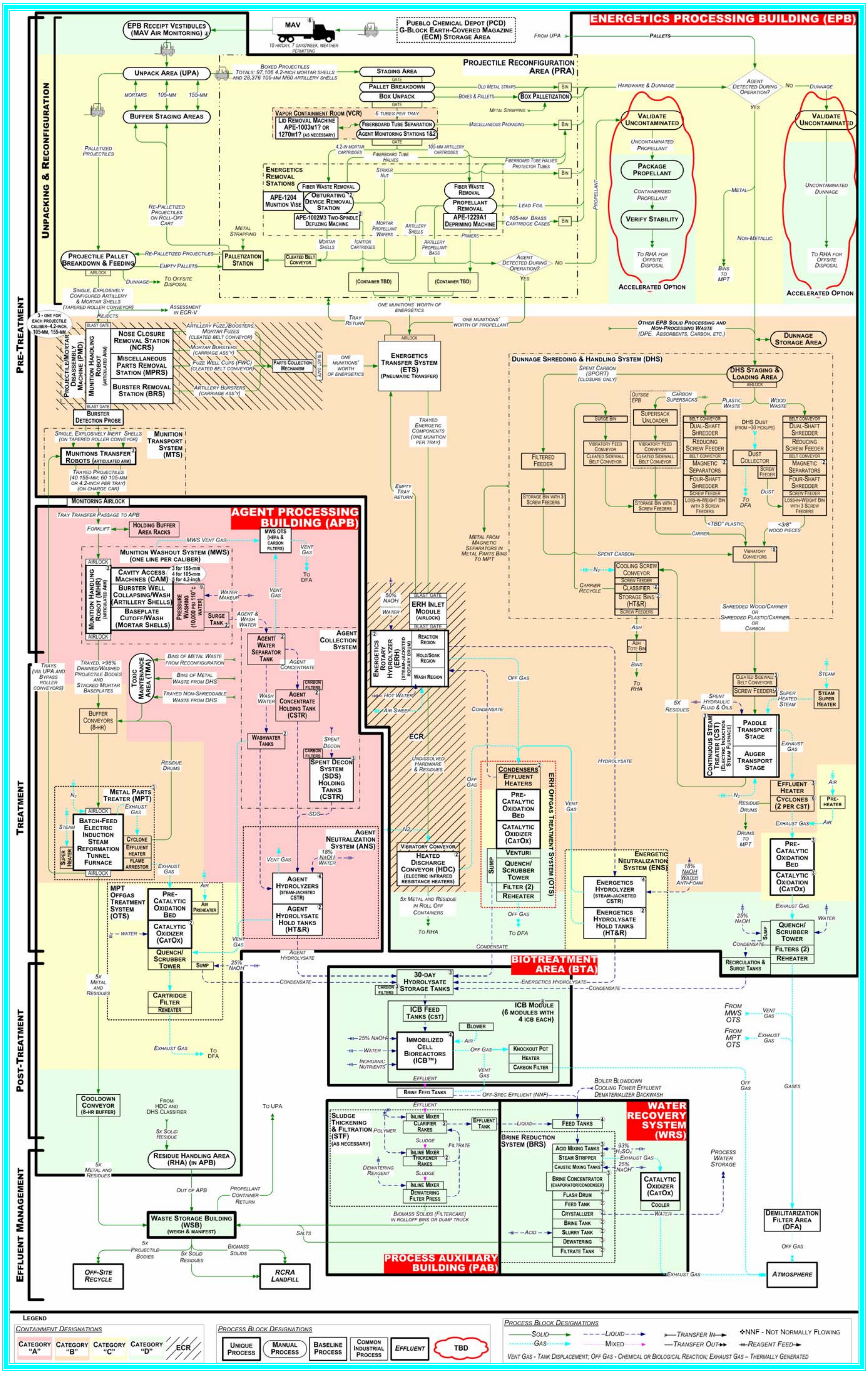
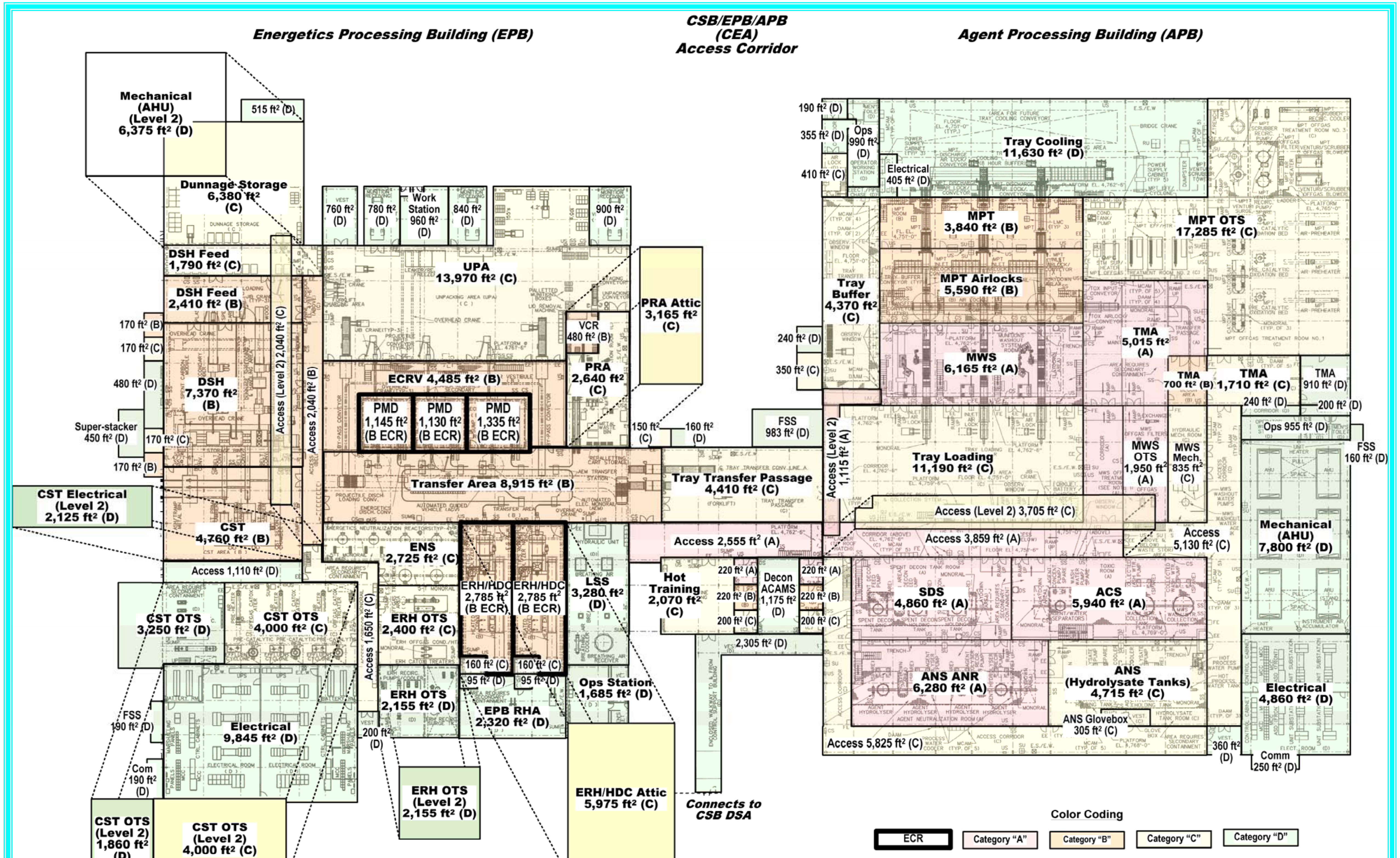


Figure 2-4 – Detailed PCAPP Process Flow Diagram



Source: Mitretek Systems based on PCAPP Intermediate Design Drawing24852-P1-EPB-P0030

See Table 2-3 on page 20 for acronym descriptions

Figure 2-5 – 3-Line Process – EPB/CEA/APG Floorspace Layout

2.2.3 Facility "Size" Assessment

As part of Mitretek's evaluation, a high-level examination of the equipment layout within the EPB and APB was conducted. To some extent, this was also driven by questions about the general "size" (footprint) of the process facilities. Of particular interest were the EPB and APB.

The site appears appropriately sized with all of the necessary amenities required for chemical demilitarization. For the most part, rooms in the EPB and APB also appear to be appropriately sized. These facilities, unlike the incineration facilities, were developed using three-dimensional (3D) physical layout modeling techniques to ensure adequate space for equipment, personnel mobility, and maintenance activities. Incineration lessons learned were also incorporated. Mitretek did not conduct a detailed assessment of the 3-D model layout and, further, does not see the need. Although there may be places for minor adjustments, these are likely to provide only marginal cost savings. The best savings result from removal of process equipment, along with the associated reduction in facility size—these are addressed in the alternatives cited in this report.

Site layouts and detailed layouts of the EPB (including the CEA) and APB are provided in Figure 2-5 on page 25. These drawings address floorspace by contamination category but not the mezzanine levels, which are difficult to factor into a cost assessment. Although the EPB/APB/CSB buildings are visibly larger than the baseline MDB, such a comparison is misleading. Other factors must be taken into account, including the following:

- PCAPP project objectives (including a "total solution" philosophy)
- PCAPP scope of operations
- PCAPP treatment strategies
- Incineration versus neutralization
- Building floorspace versus footprint

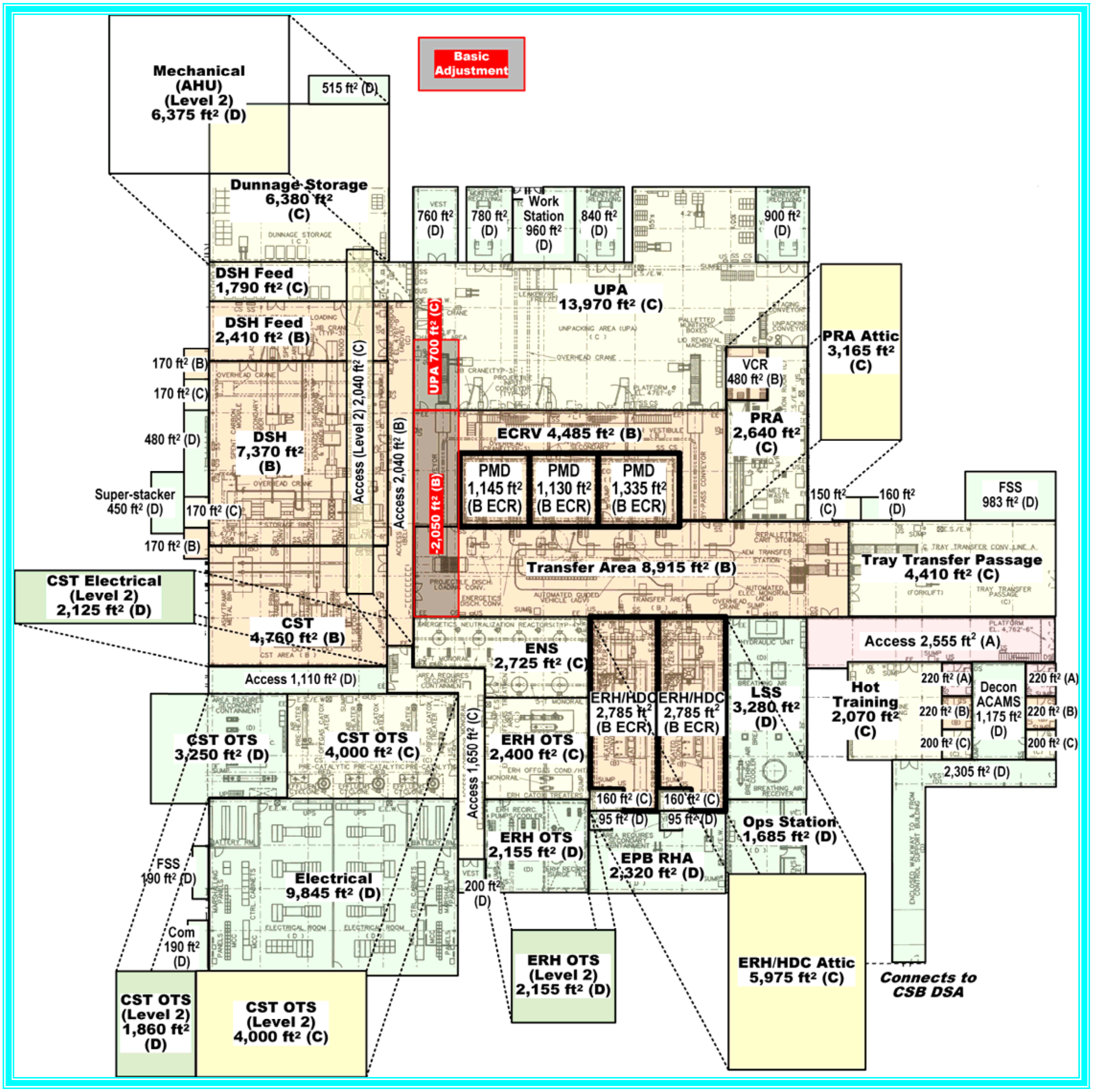
In addition, the comparison should only address operating areas directly related to the process; ancillary areas, such as utility rooms, offices, and personnel access features (entry/egress corridors, airlocks, vestibules, life support systems, etc.) should not be factored since they are unique to the facility configuration.

Mitretek has also conducted a design evolution assessment, which includes an assessment of PCAPP using the above factors, as well as others. This will be included in a separate report since it is primarily to detail a programmatic lesson learned. The alternatives are discussed in this report and Mitretek could not identify any major adjustments to the base case in regards to floorspace, resulting in little impact on the cost assessment (and providing little apparent value to the path forward).

2.2.4 Basic Adjustments

Basic adjustments represent processing areas that could be reduced or should be investigated for reduction regardless of other alternatives.

One basic adjustment is the removal of one tray bypass line in the EPB, as shown in Figure 2-6 on page 28. This appears to be an artifact of the baseline incineration facility layout and is not needed for the PCAPP design because of a different robotic tray-loading configuration. Upon initial observation, the Tray Transfer Passage between the EPB and APB may appear large, but this space is typical for forklifts maneuvering munition trays. Since the bypass line reduction is the only basic adjustment, it is factored into the LCCE for the 2-line processes (Mitretek did not change the equipment, facility size, or layout for the 3-line LCCE).



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP) Drawing 24852-P1-000-P0030
See Table 2-3 on page 20 for acronym descriptions

Figure 2-6 – Basic Adjustments to 3-Line Process – EPB Floorspace Reductions

2.3 Alternatives

This section discusses process alternatives evaluated by Mitretek using criteria cited in §2.1.1 on page 13.

2.3.1 Process Line Alternatives

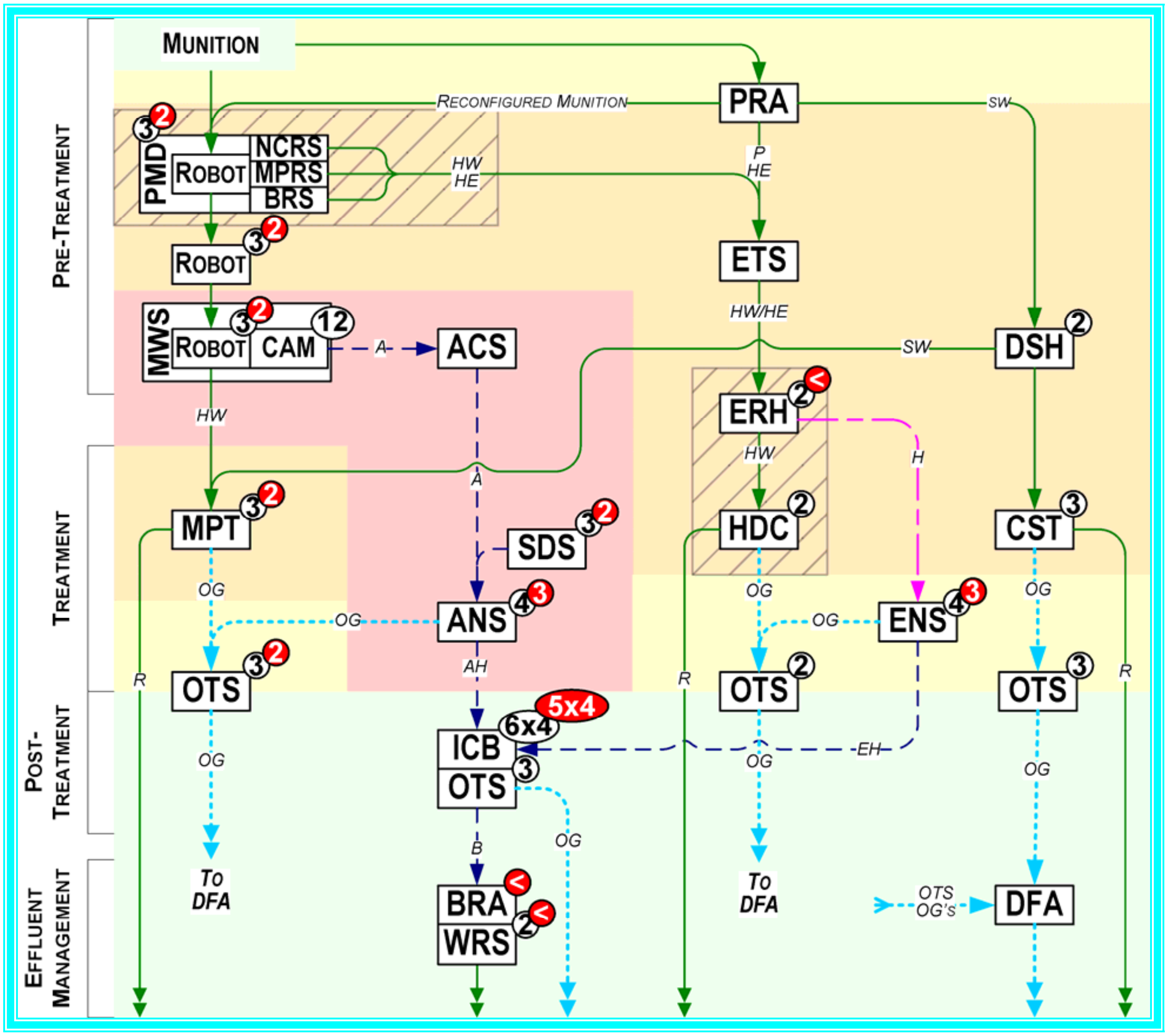
2.3.1.1 The 2-Line Process

The 2-line process alternative reduces the base case design from three munition processing lines to only two for the PMD, MWS, and MPT systems. Other systems, such as the ANS, ENS, and ICB are reduced also based on the expected capacity decrease. The two ERH/HDC systems are not reduced in number. This includes all major processing equipment as well as the associated materials handing systems (MHS). The 2-line process alternative removes roughly 13% of the process equipment by unit count (see Table A-11 on page 134) and reduces the EPB /APB by nearly 29,000 ft^2 (10%).

For the 2-line process, the BFD is shown in Figure 2-7 on page 30, and the facility layouts are shown in Figure 2-8 on page 31 and Figure 2-9 on page 32, and the SF change summary is shown in Table 2-5 on page 30.

The previous Analysis of Alternatives (AoA 2004) eliminated a DSH line in addition to removing a munition processing line. Mitretek could not ascertain the AoA's rationale for this. The amount of dunnage feed is only decreased by a small amount (maybe [redacted])—there are still two munition processing lines, reconfiguration, and secondary wastes. Removal of a DSH line would require additional buffer storage and/or extension of treatment operations into closure. The treatment strategy for dunnage was unclear in the previous AoA. Mitretek chose to address removal of a DSH line as part of the offsite dunnage disposal alternative discussed in §2.3.2 on page 32, leaving this alternative to strictly eliminate one munition processing line.

Although the net-explosive weight (NEW) presence in the ERH is lowered, the explosive blast load quantity is based on the Maximum Credible Event (MCE), which should only be comprised of a fraction of the total quantity present, as well as other factors. Mitretek did not have the blast load evaluation at the time of this study, but it is expected to be less than 10 bursters. Given the feed rate of bursters and the rate of decomposition in the ERH, decreasing from three processing lines to two may not dramatically change the MCE for the ERH ECR. Therefore, Mitretek did not assume a savings in the ECR construction for the 2-line process. It should be noted that given the high cost of explosion containment (see §A.2.1, *Facility Construction Cost Factors*, on page 127), changes in the MCE could result in a notable savings.

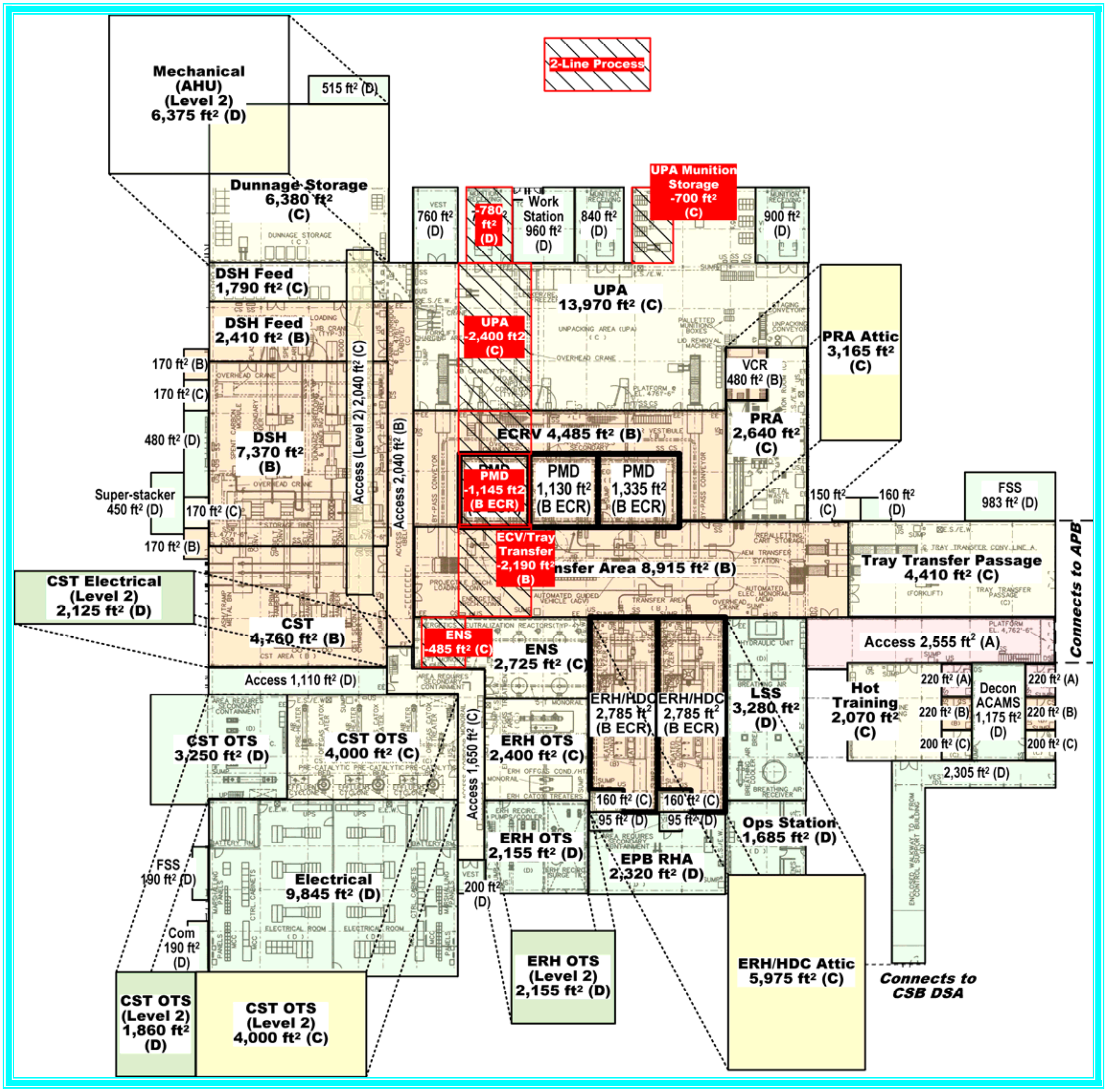


Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP)
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-7 – 2-Line Process Alternative – Block Flow Diagram

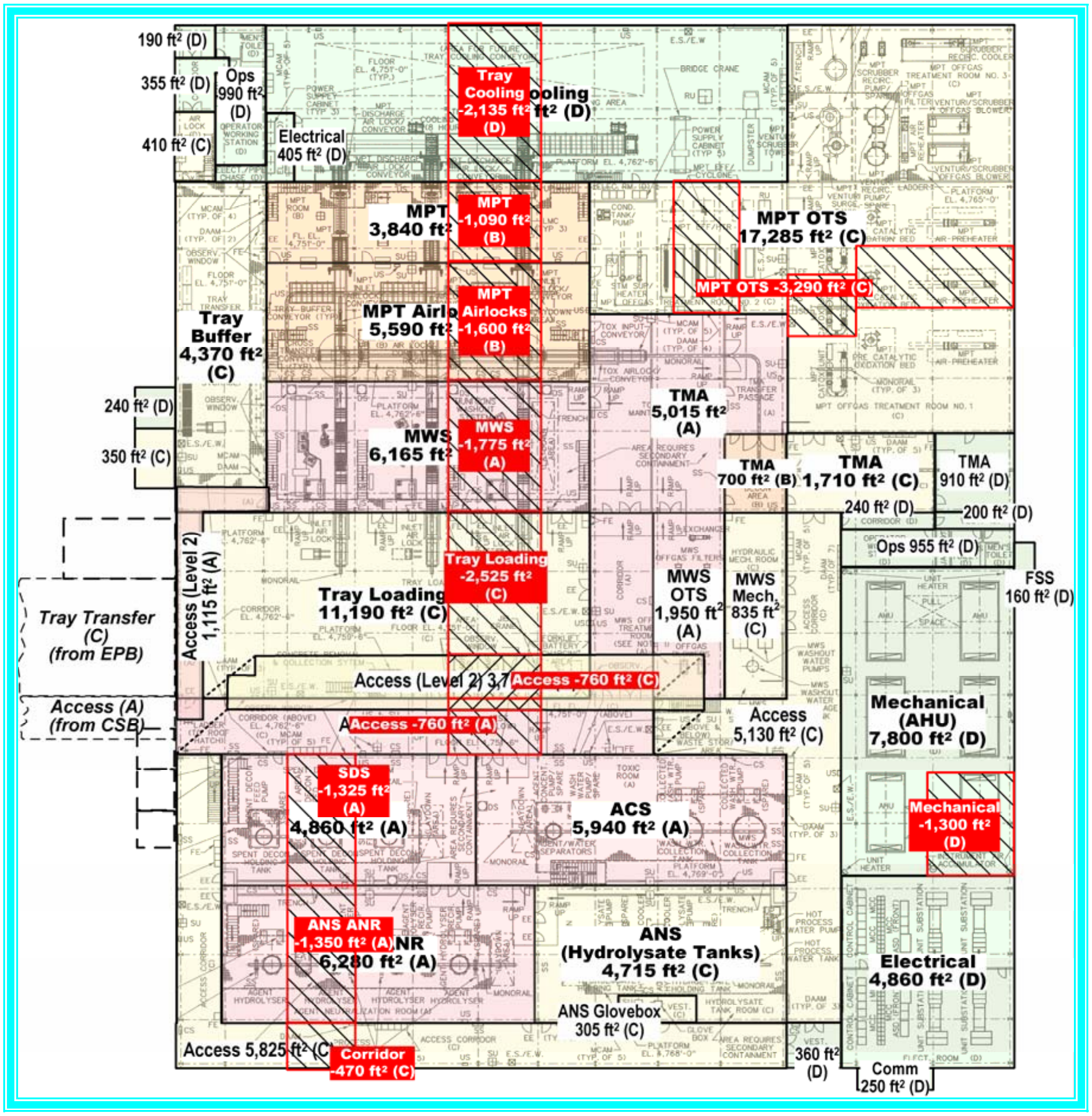
Table 2-5 – 2-Line Process Alternative – SF Change Summary

	Area by Contamination Category (ft^2)					
Alternative	**A**	**B ECR**	**B**	**C**	**D**	**Total**
3-Line	39,895	9,180	41,375	115,110	76,840	282,400
2-Line Changes	-5,205	-1,145	-6,925	-11,325	-4,215	-28,815
% Change	-13%	-12%	-17%	-10%	-5%	-10%



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP) Drawing 24852-P1-EPB-P0030
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-8 – 2-Line Process Alternative – EPB Floorspace Reductions



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP) Drawing 24852-P1-APB-P0030
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-9 – 2-Line Process Alternative – APB Floorspace Reductions

2.3.2 Offsite Disposal Alternatives

2.3.2.1 Offsite Disposal—Dunnage

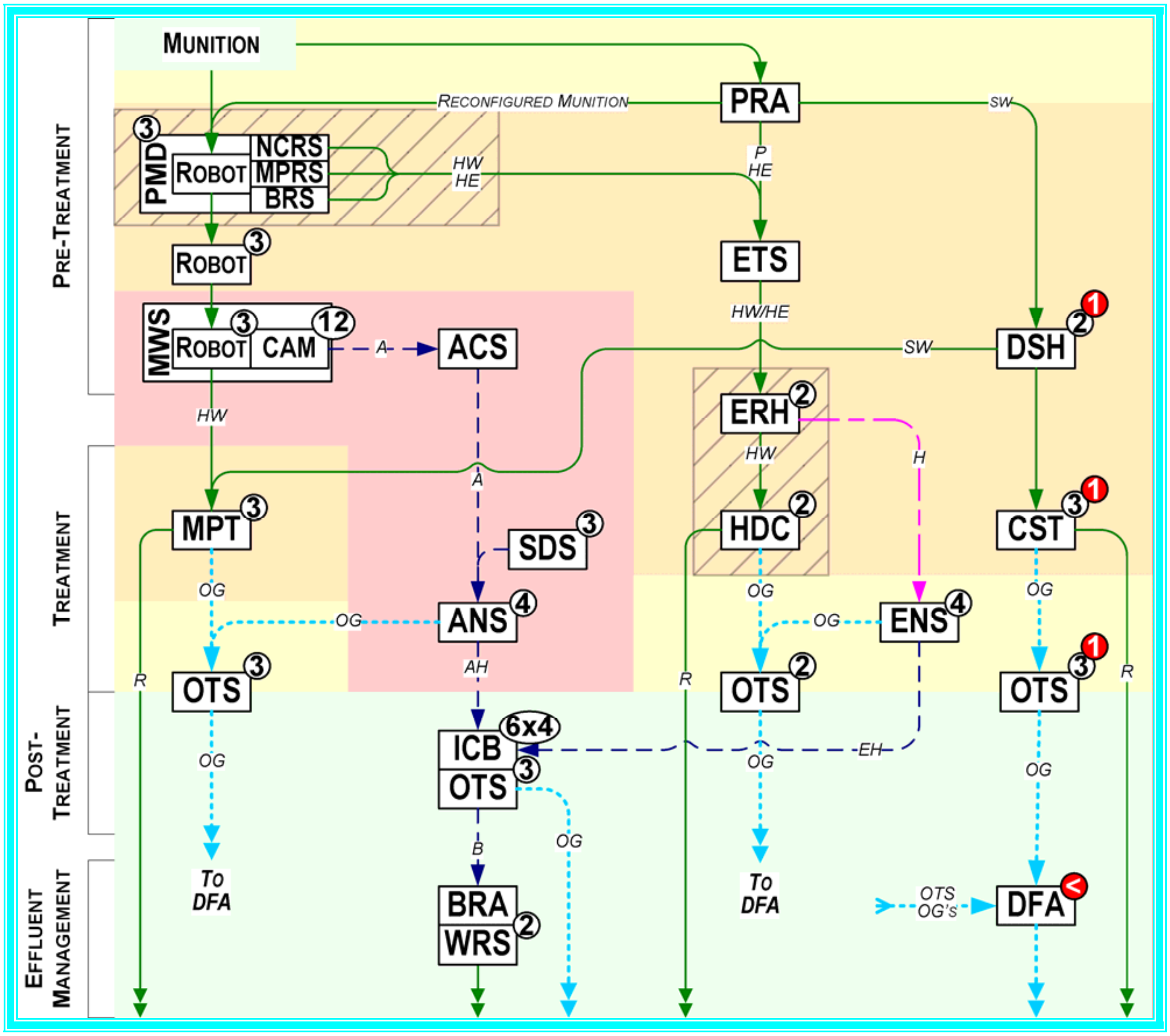
A significant quantity of dunnage is generated from munition reconfiguration and from storage pallets. This alternative ships uncontaminated wood (pallets, boxes, etc.) and cardboard (tubes, wrappings, etc.) offsite for disposal instead of onsite treatment by the DSH and the CST. This alternative eliminates the wood DSH, two CSTs/CST OTSs, and the associated materials transport equipment and controls as shown in Figure 2-10 on page 34. In addition, metal bandings can also be sent offsite rather than to the MPT, reducing some MPT throughput burden.

The changes in EPB size are shown in Figure 2-11 on page 35 and summarized in Table 2-6 below; there are no changes to the APB for offsite dunnage disposal. The dunnage storage area is decreased, but it would probably require an increase in the WSB (less expensive floorspace) to accommodate packaging for offsite shipment. Mitretek has included this alternative in its recommended process with associated cost savings provided in §5.4.3 on page 94 and recommends further study.

Table 2-6 – Offsite Disposal of Dunnage Alternative – SF Change Summary

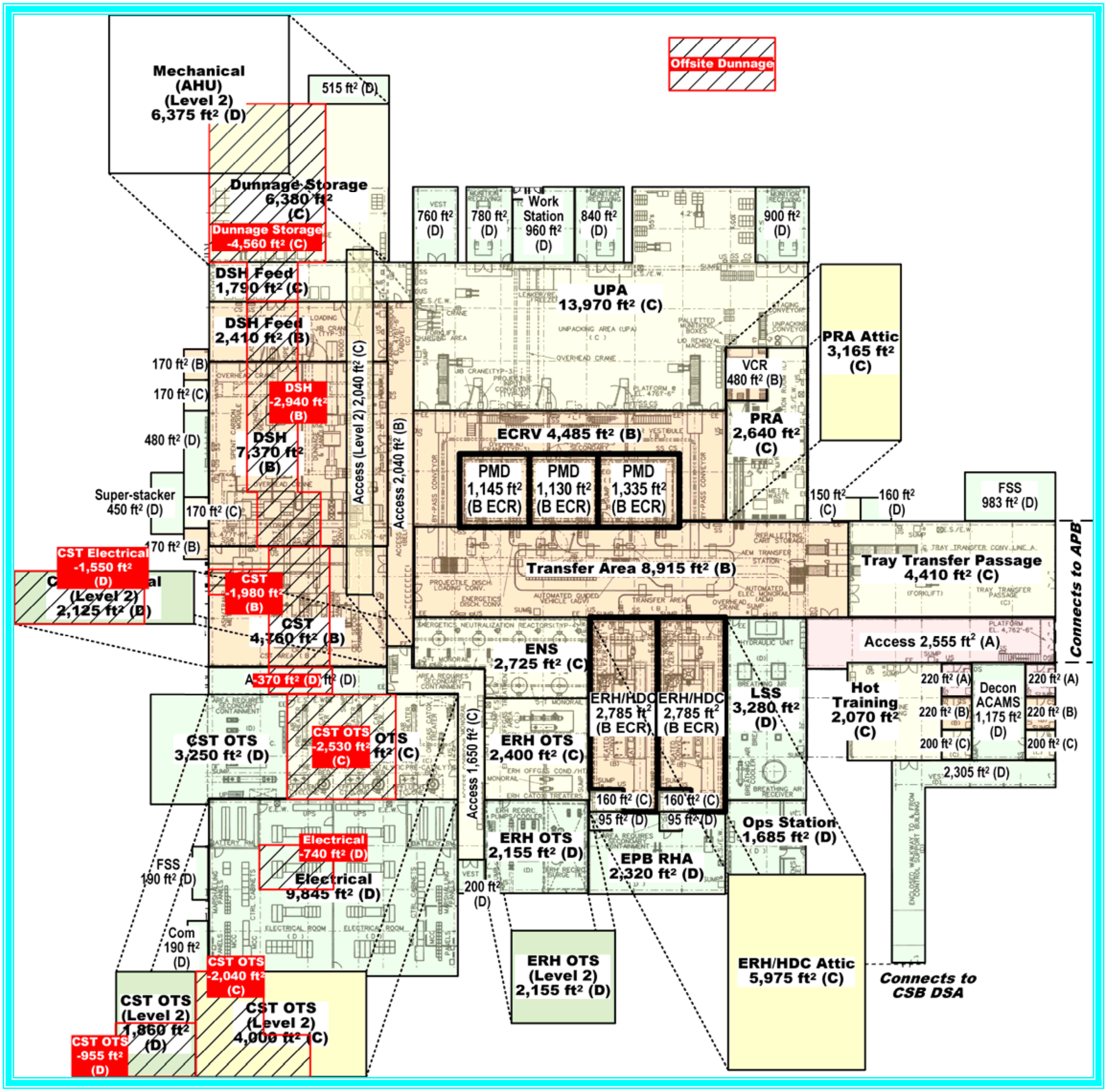
Alternative	Area by Contamination Category (ft^2)					Total
	A	B	B ECR	C	D	
3-Line	2,995	9,180	31,245	58,420	47,300	149,140
Offsite Dunnage Disposal Changes	0	0	-4,920	-9,130	-3,610	-17,660
% Change	0%	0%	-16%	-16%	-8%	-12%

Regardless, an onsite treatment process is necessary for dunnage when it does not pass clearance protocols, which is expected to be infrequent. However, a dual-feed (wood and plastics) DSH would be required, lowering realized equipment savings unless another treatment process is used (see §2.3.3 on page 39). If this alternative is implemented, Mitretek recommends not using a dual feed (wood and plastics) DSH, but rather use an MPT (as available) to process the contaminated dunnage (some onsite storage may be necessary). Mitretek recommends (if possible) that the DSH not be used to process any contaminated material. Secondary waste processing methods have been considered by the SC for the MPT and MPT should be capable of processing this waste in the small quantities expected. However, to date no demonstration testing has been conducted to ensure its capability, capacity, and identify any necessary design modifications.



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP)
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-10 – Offsite Dunnage Disposal Alternative Block Flow Diagram



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP) Drawing 24852-P1-EPB-P0030
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-11 – Offsite Dunnage Disposal Alternative – EPB Floorspace Reductions

2.3.2.2 Offsite Disposal—Propellant

Propellant is generated in the PRA in the form of wafers and bags. This alternative ships uncontaminated propellant offsite for disposal instead of onsite treatment in the ERH and ENS. Propellant is not a significant waste stream at PCAPP. No equipment is eliminated (same as 3-line process shown in Figure 2-1 on page 19); even the processing capacity of the ERH will not have a dramatic change. However, as noted in the FOCIS report, propellant has proven difficult to process in the ERH; cloth remaining after treatment is difficult to transfer to the HDC, although cloth has been transported more successfully in recent ERH/HDC interface testing. By sending propellant offsite, any technical risk associated with processing propellant is eliminated from the process.

Although the net-explosive weight (NEW) in the ERH is lowered, the explosive blast load quantity is based on the Maximum Credible Event (MCE), which should only consist of a fraction of the total quantity present, as well as other factors. Mitretek did not have the blast load evaluation at the time of this study, but the propellant is not a significant factor. Given the feed rate of propellant and the rate of decomposition in the ERH, decreasing from three processing lines to two may not dramatically change the MCE for the ERH ECR. Therefore, Mitretek did not assume any savings in the ECR construction for the offsite propellant disposal alternative. However, given the high cost of explosion containment (see §A.2.1, *Facility Construction Cost Factors*, on page 127), changes in the MCE could result in significant savings.

Conversely, propellant packaging and shipment will require a larger WSB with increased fire-protection capabilities (as well as other cost factors discussed in §5.4.3 on page 94). Given these factors, the actual tangible savings may be marginal; it is the intangible benefits that make this alternative worthwhile. Mitretek has included this alternative in its recommended process with associated cost savings and recommends further study.

2.3.2.3 Offsite Disposal—Activated Carbon

This alternative ships uncontaminated activated carbon offsite for disposal instead of onsite treatment in the DSH and the CSTs. There is no corresponding alternative in the FOCIS report. Carbon should not be a significant waste stream at PCAPP until closure. Little equipment is eliminated by this alternative—just the carbon system in the DSH room. In addition, activated carbon is used as a carrier for size-reduced plastics in the CST. Some carbon can be kept unless toxicological agent protective (TAP) gear is sent offsite for disposal, as presented §2.3.2.4 on page 37, but a common aggregate would be equally effective.

The benefit of this alternative comes from not having to manually break down the filter trays and removing any technical risk associated with onsite processing. Other CDFs plan to send intact carbon filter trays to TSDFs for disposal. As with other waste sent offsite, carbon must be verified uncontaminated. Such verification must be in accordance with an approved Equipment Decontamination Plan incorporating health-based criteria—practices are currently being developed in conjunction with the new Airborne Exposure Limits (AELs). It is the current Army position that if there has never been a breakthrough of the first two carbon banks, downstream banks should be considered uncontaminated, which is validated by historical records. In addition, methods have recently been developed to detect agent in carbon. The combination of these two factors makes this approach technically feasible. Given these factors, the actual cost savings may be marginal but certainly worthwhile since it removes any risk associated with spent carbon treatment. Mitretek did not include this alternative in its recommended process and did not assess the cost savings but strongly recommends further study.

2.3.2.4 Offsite Disposal—Toxicological Agent Protective (TAP) Gear

This alternative ships uncontaminated TAP gear offsite instead of onsite treatment in the DSH and CST. This alternative eliminates the plastics DSH and associated CST and CST OTS; it also eliminates the aggregate feed system used to assist in plastics processing through the CST. Essentially, it provides the same reduction as offsite disposal of dunnage, as discussed in §2.3.2 on page 32. The little amount of TAP that cannot be acceptably decontaminated would be stored and fed to the MPT when appropriate. This alternative is technically feasible and likely to lower technical risk (given the performance of the CST with plastics), but further process assessments are needed to verify MPT capacity. Some political issues must also be considered, such as environmental permitting, local socioeconomics, and anti-incineration sentiments. Alternatively, if all TAP gear could be fed to the MPTs rather than sent offsite, the DSH/CST systems could also be eliminated, but extensive testing must conducted to ascertain the technical feasibility of this approach.

TAP gear consists of suits, masks, gloves, boots, air hoses, and so forth. The bulk of the feedstock consists of DPE and air supply hoses. Butyl suits and boots are monitored, decontaminated if necessary, and reused. Any TAP gear that does not pass decontamination monitoring clearing would be stored onsite and treated in the MPT when appropriate (during the operations phase if possible or during the closure phase).

Disposition would ultimately be based on decontamination (in accordance with an approved Equipment Decontamination Plan incorporating health-based criteria to the new AELs) and regulatory permitting. Some of the baseline incineration CDFs store TAP for later thermal destruction. Offsite disposal of DPE is being planned for certain baseline facilities, so the process of clearing TAP gear for offsite disposal should be resolved before PCAPP would need to implement the practice. This alternative will likely result in incineration of this waste at a TSDF, although disposal at a Subtitle “C” RCRA landfill is also possible.

Regardless, an onsite treatment process is necessary for TAP gear whenever it does not pass decontamination protocols, which is expected to occur infrequently. If this alternative is implemented, Mitretek recommends not using a dual-feed (wood and plastics) DSH, but rather using an MPT to process the contaminated plastic waste as it is available (some onsite storage may be necessary). The MPTs can process this waste, but studies would have to be conducted to ensure the MPT’s capacity. Given the potential cost savings of eliminating the plastics-related DSH capability and considering that the CST processing of plastic wastes has been problematic and still poses some technical risk, the MPT is considered to be a better approach for the small-quantities expected.

2.3.2.5 Offsite Disposal—Hot Air Decontamination

Hot air decontamination uses a simple, industrial (pre-engineered), walk-in drying oven to thermally evaporate (desorb) any residual agent from materials to non-detection levels. Mitretek does not consider hot air decontamination to be an onsite disposal alternative because it represents a pre-treatment technology rather than treatment, since agent is not destroyed, just "evaporated" and adsorbed on carbon. The operating philosophy is to "dry" the material, and not to "cook" or "burn" it, so drying temperature is typically below the melting or decomposition temperature of the material (some off-gassing may occur). Mitretek did not include this alternative in its recommended process and did not assess the cost savings, but strongly recommends further study. This device can be used to pre-treat materials such as TAP gear, dunnage, etc., as necessary for offsite disposal or before onsite treatment so as to minimize agent-contamination in the processing areas.

One specific device is the U.S. Army's Material Decontamination Chamber (MDC) (colloquially—and somewhat inappropriately—referred to as a "pizza oven"). The material is placed (or hung) in the MDC, then it is brought to temperature while the heated air is circulated inside; recirculation air is sent through HEPA and carbon filters. Once the hours-long cycle is complete, the MDC is cooled, the DPE is removed, and the air is monitored for agent.

The MDC dates back to the mid-1990s, but it is probably descended from military field decontamination practices. Many military assets could be contaminated in battle and are considered too valuable to destroy but may not be amenable to chemical surface decontamination, such as certain vehicles, aircraft, and electronic devices. Military field decontamination practices are to place these assets inside chambers and heat until agent is no longer detected, and then place the asset back into service.

The MDC was originally developed for pretreatment of DPE suits, about 24 suits per batch. DPE suits are encapsulating, supplied air TAP gear worn by personnel required to enter areas in the MDB where agent liquid or vapors are known to exist. Each suit is surface-decontaminated and air-monitored before the "entrant" is removed from the suit. These suits are then bagged in containers (typically plastic bags, with two to three suits per bag). The objective was to achieve an agent concentration below the waste control limit (WCL) (i.e., 20 PPB for GB and VX and 200 PPB for mustard). This would allow DPE to be managed off site (destroyed at a TSDF or disposed of in a RCRA Subtitle C Landfill) as an F999 hazardous waste (other waste codes may apply) or at the very least to allow the DPE to be stored in a non-ventilated, permitted storage area. (After processing, a maximum of 40 suits can be placed in a 55-gallon drum for storage and shipping.) New (and recent) requirements would necessitate decontamination to a health-based WCL defined in an approved decontamination plan (to the new AELs).

The MDC has been tested at one of the Army's technology test sites;[1] it has processed DPE from TOCDF, and is planned for use at Aberdeen Chemical Agent Disposal Facility (ABCDF), Newport Chemical Agent Disposal Facility (NECDF), and possibly other locations where

[1] The Oquirrh Mountain Facility (OMF), previously called the Chemical Agent Munitions Destruction System (CAMDS), at the Deseret Chemical Depot (DCD), Utah.

chemical agent decontamination is necessary. Hot air decontamination using the MDC at 235±5°F (113°C) was developed and successfully demonstrated for 948 DPE suits spiked with VX (field-grade), GB, and HD to establish a 24-hour nominal treatment time for normal expected contamination (up to 95 hours for spiked). Hot gas decontamination at 350°F (177°C) was demonstrated on mustard-contaminated concrete and steel structures.

Application to PCAPP would be to use a hot air decontamination oven for pre-treatment of material for offsite disposal, as part of an approved decontamination plan (using the new AELs), rather than treatment in the CST or MPT. Although the MDC has only been tested with trace agent quantities to date, it could be adapted to larger quantities of agent, even gross contamination of metal parts. MDC pre-treatment of other secondary wastes and metal parts has not been demonstrated, but the operating principle is the same. However, evaporation of mustard agent can result in its decomposition (not the material being treated, just the mustard) producing a corrosive offgas. Since more agent equates to more offgas, a small scrubber between the oven and the carbon filters may be required to minimize carbon loading and filter corrosion issues. Sizing of the oven depends on the throughput and offgas treatment requirements, but it is expected to be much less that the DSH/CST line. It also represents a simpler and probably less expensive technology. Additionally, there are political issues regarding additional environmental permitting and public acceptance, but Mitretek expects these to be manageable.

2.3.3 Onsite Disposal Alternatives

2.3.3.1 Dunnage Hydropulper Treatment

This alternative uses portions of the BGCAPP process instead of the PCAPP process for treatment of dunnage and plastics. Mitretek suggests this alternative for consideration only since the implications are unknown.

BGCAPP uses a DSH/hydropulper instead of a DSH/CST. The dunnage hydropulper was developed for BGCAPP to pre-treat and decontaminate secondary wastes for super-critical water oxidation (SCWO) treatment. This alternative removes the three CSTs, their OTSs, and the aggregate and carbon feed systems and replaces them with two hydropulpers. Low-speed and hammer mill shredders would still be required; additional equipment such as the wood micronizer, cryo-cooling equipment for TAP gear, and a more efficient dust collection system would also be required. Whereas the CST thermally treats secondary wastes into agent free solid residues, the hydropulper produces an agent free pulp/slurry. The decontaminated pulp slurry would likely require further treatment either onsite or offsite, and would be designed around treatment of the bulk slurry or filtration followed by separate treatment of the liquid and solid phases. The advantage is that this decontaminated waste stream is more easily managed. There is a technical challenge in that a monitoring method of the dunnage pulp slurry is still being developed, but it will be necessary for BGCAPP regardless. There are additional political issues (permitting and public acceptance), as well as technical issues, if onsite post-treatment is planned. Mitretek does not recommend incorporating a SCWO at PCAPP for post-treatment of the dunnage slurry.

2.3.4 Space Utilization Options

The following represent other space utilization improvement options offered for consideration. Mitretek did not consider these as processing alternatives, under the definition provided in §2.1.1 on page 13, primarily due to uncertainties and lack of data. These are not expected to provide significant benefit individually, but do have benefits that could be used to supplement other alternatives.

2.3.4.1 EPB/APB Munition Tray Transport/Buffer

The munition tray transport between the EPB and the APB and the tray loading and buffer areas in the APB represent nearly 20,000 ft^2 of Category "C" area. The current design is to transport munition trays using forklifts. A processing alternative is to use a standard conveyor transport system like that in the EPB Tray Transfer Area. Tangible benefits of such a change are unclear, but may not be a significant improvement. Savings would be mostly due to size reduction of the facility. Using Mitretek's estimated [redacted] for Category "C" area, a 50% reduction in size, for example, equals [redacted]. The equipment change is more difficult to estimate. Staffing and forklifts (and associated forklift maintenance infrastructure) would be replaced by tray transfer conveyors. It is expected the costs would not be dramatically different. This change more of a process refinement rather than an alternative as defined in §2.1.1 on page 13. Mitretek did not assess this option further.

2.3.4.2 Dunnage Storage/Buffering

PCAPP was designed for real-time treatment of dunnage. The Dunnage Storage Area is used as a buffer, which places dunnage in an 8,160 ft^2 Category C area inside the EPB. Being Category C, it is part of the EPB cascaded heating, ventilation, and air conditioning (HVAC) system, which may make this storage area slightly more costly than needed. The alternatives are to not treat dunnage real time or make the storage area for dunnage a less expensive Category D area. Using Mitretek's estimates, this would be a savings of [redacted] due to the lack of cascaded HVAC), or about [redacted] less. Section 2.3.2.1 on page 32 addresses offsite disposal of dunnage, which mostly eliminates this area in favor of shipment offsite. However, this alternative represents a contingency if offsite dunnage disposal is not allowed (currently offsite dunnage disposal appears probable). Mitretek recommends further study of non-real time dunnage treatment; the change of the Dunnage Storage Area from Category C to D is only suggested for consideration since it does not represent a significant savings and represents more of a process refinement.

Non-Real Time Dunnage Treatment

This alternative stores/buffers dunnage surge outside the EPB, elsewhere on site, until it can be processed. This alternative allows the elimination of one DSH system and two CSTs/CST OTSs, similar to the offsite dunnage disposal alternative discussed in §2.3.2.1 on page 32, by storing/buffering the dunnage surge in a separate facility and processing it through the single DSH. This approach requires a dual-use DSH (both plastics and wood) and would likely extend dunnage treatment operations into the closure phase, rather than destroying dunnage "real time".

Category "D" Dunnage Storage Area

There are two alternatives to making the Dunnage Storage Area Category D: isolation or separation. One is to use a partition wall to isolate the Dunnage Storage Area from the Category C DSH feed area and designate it Category D. The other alternative is a storage area outside the EPB that would be contamination Category D, rather than a C, because it will only contain uncontaminated material. This approach would eliminate the majority of the Category C area in the EPB in favor of a Category D area. This may also allow the Air Handling Units (AHUs) on the second floor to be lowered to the ground level.

2.3.4.3 Contaminated Process Equipment Minimization

Consideration was made to minimize areas where contaminated material is processed. This has advantages of reducing the cascaded HVAC areas, eliminating TAP gear for maintenance, and potentially simplifying closure. No single area could be totally eliminated, but feed of contaminated material to the DSH could be minimized or done under special end-of-operations campaigns. It is already assumed that gross-contaminated (not surface-decontaminated) material generated in the APB will be treated in the MPT and not transferred to the EPB DSH. Gross, liquid-contaminated material cannot be fed to this area and is unlikely to be generated in the EPB. The amount of contaminated dunnage is expected to be very low. The remaining feed, DPE/plastics, are typically surface decontaminated to non-detect levels. Although the presence of agent is expected to be negligible, the DSH would be considered Category B during these processing campaigns. This approach would only process uncontaminated material and store contaminated material until a later contaminated material campaign. This approach would have to be combined with non–real-time dunnage treatment alternative discussed previously. Processing all contaminated solid material in the MPT would be preferred since it would make the DSH line Category D, but it may require extensive development testing and MPT redesign. The hot air decontamination could also be used to minimize or eliminate agent from secondary wastes before onsite treatment.

2.3.4.4 Contamination Category Downgrading

Mitretek suggests reassessment of some of the contamination categories assigned to areas to downgrade them. BPT has admitted to purposely designing some areas more conservatively and has been upfront about potentially operating them at lower contamination ratings. In addition, some category designations were imposed during the various design reviews. Regardless of the origin, some of these areas appear to be overly conservative given the nature of the operations. For some, consideration should be made to using a designation such as "B/C", where under some conditions (or campaigns) agent vapor may be present, but routinely none will be. It should be noted that these changes are likely to provide only marginal cost savings (not assessed in this report) since the HVAC system, although a high-cost line item, will not change the overall LCCE dramatically. In addition, when an area has a dual designation, it must be designed for the higher of the two. Suggested areas for consideration are shown in Table 2-7 on page 42.

Table 2-7 – Contamination Category Downgrading Suggestions

Location/Operating Unit		Contamination Category Currently	Contamination Category Suggested	Rationale/Approach
EPB	Dunnage Storage Area	C	D	Do not store 3X material here; No reason for dunnage not identified as contaminated during UPA operations to be in a "C" area (can be stored outside)
	DSH	B	B/C	Normally not processing contaminated material.
	CST	B	C	Agent release (to room) from the negative pressure system unlikely
	CST OTS	C	D	Agent release (to room) from the negative pressure system unlikely; highly unlikely after the superheater
	DSH/CST/CST OTS	B, C, D	D	Process contaminated material only in the MPT
	PMD ECR, ECRV, ERH/HDC, Tray Transfer Corridor	B	B/C	In-process leakers are not routine. "C" unless agent detected or during leaker/reject campaigns
APB	ACS, ANS, SDS	A	A/B	Liquid agent only present during some maintenance operations
	MPT OTS	C	D	Agent release (to room) from the negative pressure system unlikely; highly unlikely after the superheater

2.3.5 Safety Impacts of Alternatives

In the course of examining the various process alternatives described above, Mitretek also considered the safety impacts of the alternatives. For the 2-line process alternative, there are no additional safety-related issues expected. The safety review activities already being undertaken by the systems contractor through the hazard and operability (HAZOP) review process are intended to ensure that individual systems are designed to preclude any significant risks to the worker or the public. Reducing the number of process lines from three to two will not alter the safety features already being engineered into each system.

The offsite disposal of dunnage is not expected to pose any significant additional safety-related concerns. In the current design, workers in the unpack area are already handling the dunnage to transport it to the DSH area for processing. For the offsite disposal option, workers would handle the dunnage materials in a similar fashion, transporting it instead to a WSB for preparation for offsite shipment. While a second handling step would be required at the WSB for preparing the offsite shipment, the nature of the activity and the non-contaminated condition of the dunnage materials should not pose any significant additional risk.

The offsite disposal of propellant does raise some additional safety concerns that need to be reflected in the operational design. As mentioned in §2.3.2.2, *Offsite Disposal—Propellant*, on page 36, packaging and shipping propellant will require a larger WSB with increased fire-protection capabilities. Additionally, prior to offsite shipment, the propellant must be tested to ensure that any stabilizers utilized in the manufacture of the propellant have not degraded over time to an unstable condition. However, the Army has extensive experience in stabilizer testing and in the safe transport of propellant; it is assumed that this knowledge can be brought to bear on the PCAPP design so that these operations can be designed to be performed in a safe manner.

Offsite disposal of both uncontaminated activated carbon and TAP gear are not expected to pose any significant safety concerns. Activated carbon is a common industrial material, and protocols for its safe handling and transport can readily be implemented. Historical records can be used to demonstrate that downstream banks should be uncontaminated as long as there has never been a breakthrough of the first two filter banks. Additionally, methods have been developed to detect the presence of agent in carbon, enabling confirmation that carbon is not agent-contaminated. For offsite shipment of TAP gear, it will be necessary to implement a process for clearing TAP gear to confirm no agent contamination prior to offsite disposal. Because the offsite disposal of TAP gear is being planned for certain baseline facilities, these processes should be well established and readily transferable by the time that PCAPP is set to begin processing.

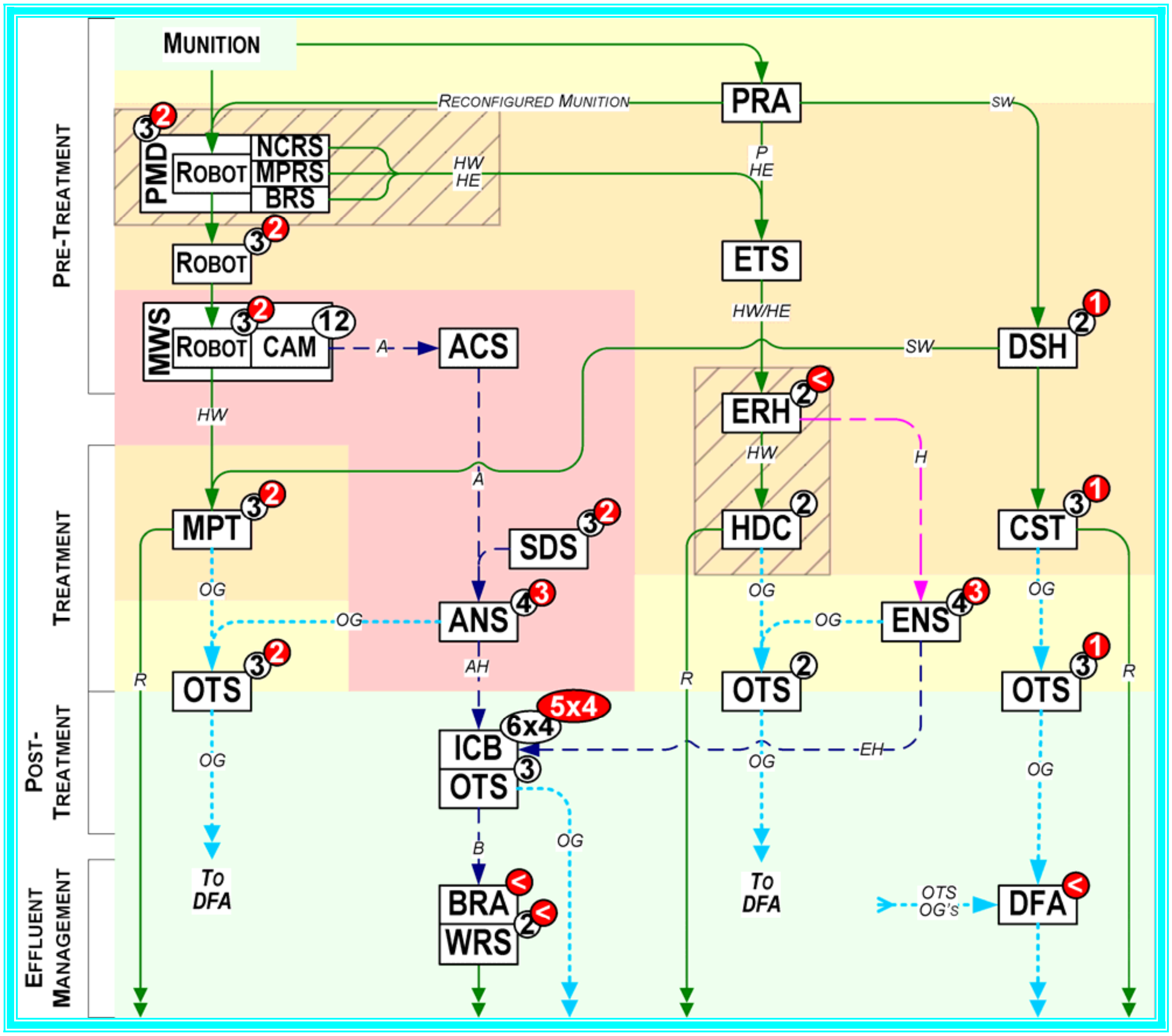
The hot air decontamination process is in essence a “new technology” as it applies to application in a demilitarization facility; as such, it would require a comprehensive HAZOP assessment prior to its incorporation into any design. However, given the Army’s extensive experience in thermal treatment and agent monitoring systems, it is reasonable to expect that such a unit could be designed to be operated without significant risk to workers or the public.

Collectively, implementation of any of the alternatives considered by Mitretek is not likely to pose any significant additional safety-related risks. Of the various options considered, the hot air decontamination process would require the greatest amount of effort to safely integrate into the PCAPP facility design.

2.4 Recommended Design Alternatives

2.4.1 Mitretek Recommended Process

The recommended design alternative, as used for a LCCE in this report, is a 2-line process (see §2.3.1 on page 29) with offsite disposal of uncontaminated dunnage (see §2.3.2 on page 32) and uncontaminated and stable propellant (see §2.3.2.2 on page 36)). The BFD for the recommended alternative is shown in Figure 2-12 on page 44, the square footages are shown in Figure 2-13 on page 45. Although there are a number of other economically attractive and technically feasible offsite disposal alternatives discussed in this report, these two offsite alternatives have the greatest chance of success given the current PCAPP political environment. This process represents what Mitretek considers the ACWA program’s “best foot forward” from a technical and LCCE position, and a good starting point for considering other alternatives, such as those discussed above and others deemed beneficial by PM ACWA.



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP)
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-12 – Mitretek Recommended Process Block Flow Diagram

Table 2-8 – Mitretek Recommended Process – SF Change Summary

	Area by Contamination Category (ft^2)					
Alternative	**A**	**B ECR**	**B**	**C**	**D**	**Total**
3-Line	39,895	9,180	41,375	115,110	76,840	282,400
Mitretek Recommended Process Changes	-5,205	-1,145	-11,845	-20,455	-7,825	-46,475
% Change	-13%	0%	-29%	-18%	-10%	-16%

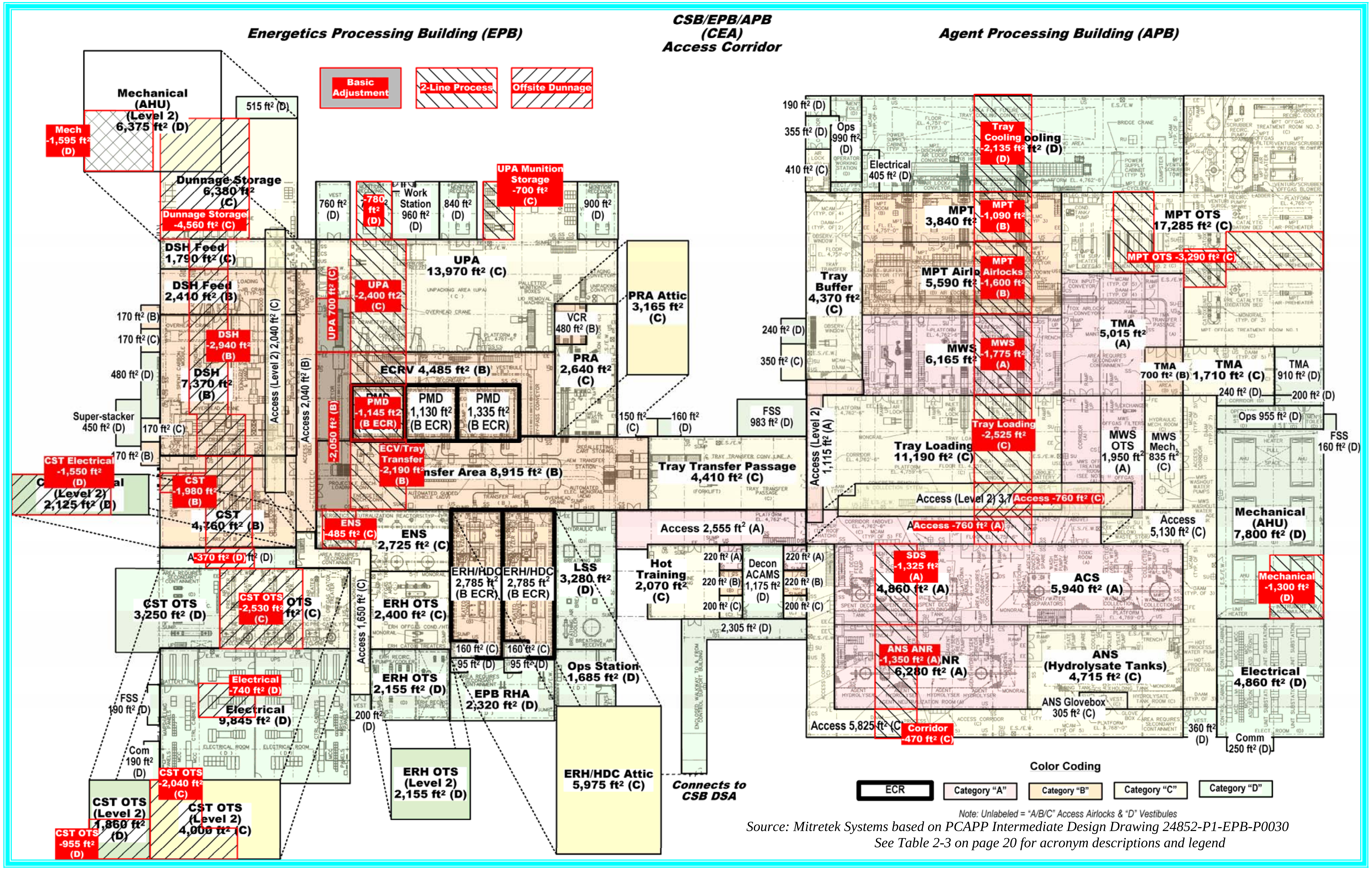


Figure 2-13 – Mitretek Recommended Process – EPB/APB Floorspace Reductions

2.4.2 Other Recommended Process Alternatives

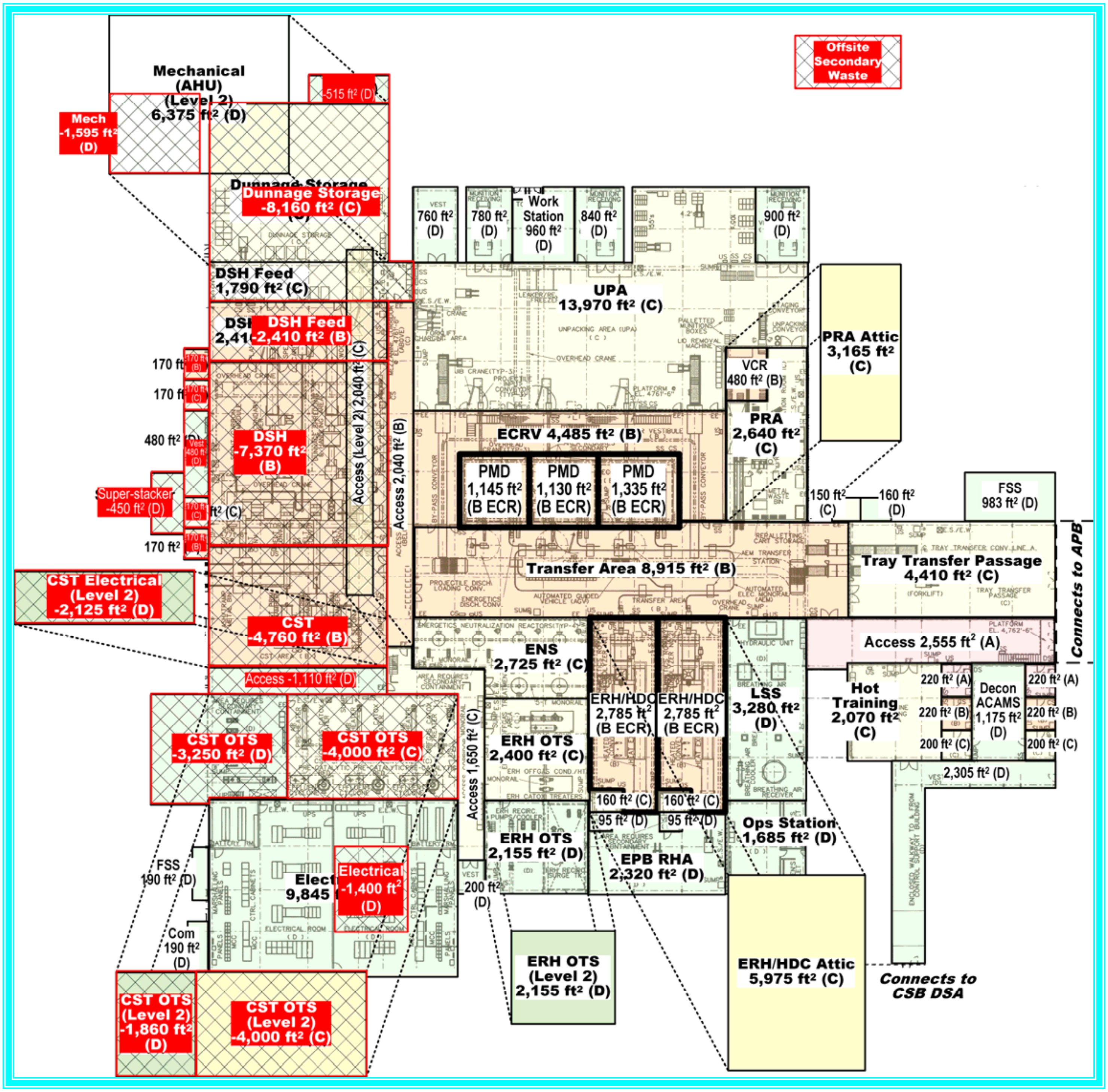
Offsite Disposal of Uncontaminated Secondary Waste

Mitretek recommends further study of offsite disposal of all uncontaminated secondary waste, especially spent, uncontaminated activated carbon (discussed in §2.3.2.3 on page 36) and TAP gear (discussed 2.3.2.4 on page 37). This approach would eliminate the DSH/CST lines and process all contaminated secondary waste in the MPTs. Facility reductions are shown in Figure 2-14 on page 47. This reduction would be offset by the space needed for hot air decontamination (discussed in §2.3.2.5 on page 38), if required, probably in the APB.

Table 2-9 – Offsite Disposal of Uncontaminated Secondary Waste – SF Change Summary

	Area by Contamination Category (ft^2)					
Alternative	**A**	**B ECR**	**B**	**C**	**D**	**Total**
3-Line	2,995	9,180	31,245	58,420	47,300	149,130
Offsite Secondary Waste Disposal Changes	0	0	-14,885	-16,500	-12,755	-44,140
% Change	0%	0%	-48%	-28%	-27%	-30%

Alternatively, all TAP gear and carbon might be processed in the MPTs if it could be shown that there is sufficient capacity (trade study). However, Mitretek maintains simplifying the process through offsite disposal improves manageability. In addition, sending waste offsite has proven to be less costly at other baseline facilities. Ultimately, offsite disposal of any waste will require public acceptance. Waste could also be stored onsite until closure, postponing the final decision for onsite or offsite disposal. Additionally, Mitretek recommends investigation into the use of hot air decontamination as necessary to support offsite disposal of secondary waste (as part of a decontamination plan to the new AELs).



Source: Mitretek Systems based on PCAPP Intermediate Design Drawing 24852-P1-EPB-P0030
See Table 2-3 on page 20 for acronym descriptions and legend

Figure 2-14 – Offsite Disposal of Dunnage, TAP Gear, and Carbon – EPB Floorspace Reductions

3 Schedule

3.1 3-Line "Base Case" Process

Table 3-1 below summarizes the BPT and the IGCE schedules for PCAPP. The paragraphs that follow discuss Mitretek's understanding of BPT's strategy and justification of their estimates. Mitretek's analysis of the factors affecting systemization, operations, and closure schedule is also presented, along with Mitretek's estimates for schedule durations for these phases. Both "most likely" and "pessimistic" estimates have been developed. For the purpose of this study, "most likely" is considered as a realistic estimate based on engineering judgment and historical experience at chemical demilitarization facilities; it assumes that the risks associated with particular life cycle phases are manageable. "Pessimistic" estimates include additional time and additional risk factors. However, major shutdowns due to unlikely but possible events (e.g., agent release, safety shutdown, change in regulations, unusual munition/agent condition/ composition, litigation or public protests, or weather catastrophe) were not considered because it is too difficult to reliably estimate their occurrence and the resultant effect on schedule.

Figure 3-1 on page 49 shows the schedule estimates that have been developed and will be discussed in the following sections. Note that pessimistic schedules for individual phases are shown to be additive to each phase duration; however, the resultant schedule at PCAPP may be a combination of most likely and pessimistic schedules for the different phases.

Table 3-1 – Schedule Duration Estimates for the 3-Line Process

	Duration (months)	
Life Cycle Phase	**BPT Estimate [a]**	**IGCE Estimate [b]**
Systemization [c]	[redacted]	[redacted]
Operations		
Closure		

[a] *BPT Integrated Master Schedule, 26 May 2004*
[b] *(IGCE 2004)*
[c] *Systemization partially overlaps with construction ([redacted] overlap)*

3.1.1 Systemization

The IGCE systemization schedule is [redacted] total: [redacted] overlapping with construction followed by [redacted] of formal systemization. For definition purposes, systemization—while it can be somewhat arbitrarily defined by a systems contractor—begins when construction of a significant number of process units is completed, the construction phase has been completed, and shakedown and debugging of individual units can commence, ultimately leading to shakedown and debugging of integrated process lines.

{Figure removed in

this special version

of the report}

Figure 3-1 – PCAPP Schedule Comparisons (with Pessimistic Projections)

In this report, "pre-systemization" is defined as the period where systemization overlaps with construction; at the end of construction, "formal systemization" commences until the operations are initiated.[1] Since experience with live agent and energetically configured munitions cannot begin until operations, more shakedown and debugging problems are expected to be encountered after agent operations have begun because real munitions and live agent and energetics will introduce new conditions and variables (many of them unknown) that cannot be reproduced with simulants and simulated equipment training hardware (SETH). However, even though systemization-type troubleshooting will occur during the beginning of operations, resulting from the introduction of actual munitions, the end of systemization (and the beginning of operations) is defined as the day when the first live agent munition is processed.

Mitretek provided estimates for systemization length for a WHEAT PCAPP conceptual design in a report dated March 2002, *Cost and Schedule Assessment of Alternative Demilitarization Technologies for the Pueblo Chemical Agent Disposal Facility* (Mitretek 2002). While changes in the Neut-Bio process design in the past few years render these estimates outdated, the same point of contention that existed then still exists in trying to estimate the time needed for formal systemization of the PCAPP. The major disagreement—then and now—centers on how long pre-systemization can be run in parallel with construction in order to save time during formal systemization and in the overall schedule. No other demilitarization plant schedule has been as aggressive as PCAPP's in overlapping these two phases. While potential gains in total schedule may be realized by this parallel effort, there is also great risk in that inadequate designs or breakdowns in the construction schedule will have more immediate impacts on the PCAPP equipment pre-systemization schedule. There is also a limit to how much can reasonably be accomplished during pre-systemization, which the systems contractor may have not taken into account. In construction efforts of this magnitude, the greater the overlap of systemization with construction, the greater the risk of schedule slippage, especially when there is insufficient planning for performing these independent tasks in parallel. The length of the systemization phase for PCAPP will depend heavily on the following factors:

- Completeness of the offsite fabrication, testing, and debugging of individual PCAPP process units
- Degree to which pre-systemization activities are synchronized with construction

The current PCAPP schedule calls for pre-systemization to begin [redacted] into construction and run concurrently with the last [redacted] of construction. In comparison, at ANCDF, [redacted] of pre-systemization occurred during the construction phase, with the formal systemization period lasting an additional [redacted] ([redacted] total) (Marshall 2004).[2] Formal systemization times at TOCDF, UMCDF, and PBCDF were [redacted], [redacted], and [redacted], respectively (PMCSD 2004).

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[1] The [redacted] of systemization overlapping with construction in the IGCE reportedly includes [redacted] of pre-systemization followed by [redacted] of "formal systemization" type activities.

[2] This does not include [redacted] of delay due to Chemical Stockpile Emergency Preparedness Program (CSEPP) issues.

With regards to the two neutralization sites, systemization at the ABCDF lasted [redacted] and systemization was estimated to last [redacted] at NECDF (to have been completed by [redacted] but is still ongoing). However, since these two sites are significantly smaller than PCAPP or the baseline incineration sites and because causes for systemization delays are difficult to establish, their systemization times were not taken into account in estimating the duration of PCAPP systemization. It is still worth noting that ABCDF, which is roughly $1/6^{th}$ the size and complexity of PCAPP and had an ultra-streamlined schedule (the "Speedy Neut" concept), still required [redacted] of systemization.

3.1.1.1 Factors affecting Systemization Schedule

Systemization Complexity

The most compelling argument for a "long" PCAPP systemization duration with respect to baseline is the number of process units compared to baseline incineration facilities. The number of relatively new or first-of-a-kind (FOAK) systems in the PCAPP design include the following:

- 3 Linear PMDs
- 2 DSH systems (with single carbon transfer system)
- 3 Continuous Steam Treaters (CSTs) with dedicated and common Offgas Treatment System (OTS) components
- 1 Energetics Transfer System (ETS) (still mostly undesigned at this stage)
- 2 Energetic Rotary Hydrolyzer (ERHs) with dedicated and common OTS components
- 4 Energetic Neutralization Reactors (ENRs)
- 3 Munition Washout Systems (MWSs) (munition-specific Cavity Access Machines [CAMs] and an articulated arm robot)
- 3 Metal Parts Treaters (MPTs) with dedicated and common OTS components
- 2 Brine Reduction Areas (BRAs) and 2 Water Recycling Systems (WRSs) with associated water recycle loop

In addition, there are many other major systems or units with a mostly higher level of maturity, most still requiring lengthy systemization. Some of these are listed below:

- The reconfiguration room with associated ammunition peculiar equipment (APE)
- 2 nitrogen-based heated discharge conveyors (HDCs) (directly linked to ERHs)
- 2 energetic hydrolysate holding tanks
- 4 Agent Neutralization Reactors (ANRs)
- 3 Spent Decontamination System (SDS) reactors
- Agent Collection System (ACS) with 2 agent/water separators and 2 washwater collection tanks
- 2 agent hydrolysate holding tanks
- 3 outdoor hydrolysate holding tanks (30-day storage)
- 6 ICB modules (4 ICBs per module) with 4 associated OTSs
- Sludge thickening and filtration units
- Munitions transfer systems and robots in EPB and APB

- Other materials handling equipment

Finally, there are significant utility and other ancillary system requirements at PCAPP, including the following:

- Facility Control System (FCS) and Facility Protection System (FPS)
- HVAC and DFA
- Electrical
- Cooling and chilled water
- Steam
- Nitrogen
- Hydraulics
- Process air
- Fire detection and protection system
- Breathing air

Innovative Design and Streamlined Planning

The most compelling reasons for why the PCAPP systemization will be "short" with respect to historical baseline figures is that the systems contractor is planning to skid-mount and test major unit operations offsite to the extent possible and that onsite pre-systemization is scheduled to run in parallel with construction for [redacted]. In addition, PM ACWA has instituted several trade studies and Technical Risk Reduction Program (TRRP) tests that have either been completed or are presently being finalized; the results of these tests will reduce technical risks associated with FOAK systems and provide opportunities for minimizing systemization delays expected with those systems. Major time savings in the PCAPP systemization schedule can be realized by properly skid-mounting and testing these new systems at the production facilities. Another factor that favors a shorter PCAPP systemization duration is that the baseline plants had to systemize different feed lines sequentially (bulk items, projectiles, and rockets) during Integrated Plant Runs (IPRs), while PCAPP only has to systemize three different projectile lines that will run concurrently. PM ACWA has also recently initiated an extensive systemization lessons-learned study to effectively plan PCAPP and BGCAPP systemization efforts. As additional information becomes available, the systemization study may offer opportunities for proactively managing and minimizing the normal risk of systemization schedule delays and for the further refinement of systemization duration and phase overlap estimates.

3.1.1.2 Systemization Duration

Pre-systemization Activities

A comparative method of estimating is used to estimate the duration of systemization at PCAPP. Appendix C on page 150 provides 22 arguments in support of a "long" PCAPP systemization duration with respect to baseline experience. It also provides 12 arguments in support of a "short" PCAPP systemization duration with respect to baseline experience. Many arguments in support of the "long" PCAPP systemization have counter-arguments in support of a "short" PCAPP systemization. Thus, there is significant uncertainty in estimating the time required for pre-systemization and formal systemization of PCAPP; any estimate should acknowledge this uncertainty. Although pre-systemization activities are scheduled to begin [redacted] into construction, it is difficult to envision significant pre-systemization activities being accomplished during the next [redacted], when only the second third of construction is scheduled to be completed. At some point in construction, all utilities will have to be piped through the walls, equipment will have to be dropped or brought in for assembly, and utility and control connections will have to be established. This work is much more likely to be accomplished in the later third of construction rather than the middle third, pushing planned systemization activities further down in the schedule. In the last third of the construction phase, all of the units will be in place and tested independently with water or steam. It also must be emphasized that responsibility for each of the major process units cannot be transferred to a systemization team until the construction team has completed its work and all the inspections and certifications have been completed. While the systems contractor has scheduled pre-systemization to begin early in the construction phase, reasons discussed above make it clear that this is unlikely to be the case. In reality, pre-systemization is much more likely to begin when construction has been more thoroughly completed and there is less likelihood for conflict between construction activities and planned systemization activities. Thus, pre-systemization for PCAPP is more realistically scheduled to start [redacted] before construction end; for a [redacted] construction schedule, this will be [redacted] into construction.

Systemization Activities

At the conclusion of construction and pre-systemization, formal systemization can be initiated with all units/systems being systemized simultaneously, to the extent possible. It will be at this point, according to the PCAPP SOW (RFP 2002), that the following are required:

- Complete preparation of training documentation and training of personnel for operations
- Complete manual startup and operation of individual sub-systems and systems
- Integration of the control system with individual systems
- Demonstration of automated operations of the equipment, automatic response to upset conditions, and interlocks
- Performance of any environmental tests required by EPA and the state of Colorado
- Validation of agent and environmental monitors and commissioning of the MDB and air monitoring laboratories
- Demonstration of the full plant operations using SETH munitions
- Verification of response readiness for upset or contingency factors
- Completion of pre-operational survey
- Preparation of IMS to support data-generating activities

In addition, numerous design changes and corrections can reasonably be expected at the conclusion of the pre-op survey, and all of the equipment must be working reliably enough to allow the confident initiation of operations where agent and energetics are first introduced into the plant.

There are also less predictable factors that have the potential to lengthen the time required for systemization. These include, but are not limited to, the following:

- Delays in construction
- Delays in certification, permitting, and regulatory compliance activities
- Incorporation of design changes required from failed systems demonstrations
- Shortages of qualified personnel
- Delays due to approval of surrogate materials by environmental regulators

The total systemization times for ANCDF, UMCDF, and PBCDF ranged between [redacted], with an average duration of [redacted]. These durations historically account for expected technical challenges during a systemization effort as well as miscellaneous external factors that can realistically delay systemization, which unfortunately exist, but are difficult to forecast. Credit (or reduction from the [redacted] baseline average) can be applied in estimating the PCAPP total systemization period for the systems contractor's approach of building and testing the modular, skid-mounted systems offsite. There are some examples in the chemical industry where modularly constructed process units have been constructed offsite and integrated at the plant location, reducing the on-site construction and systemization times. Using this approach for a large chemical demilitarization facility is considered innovative and extremely challenging, where potential gains (a reduced systemization period) may justify the overall risk. However, the assumption that this approach will greatly reduce on-site systemization times from what has occurred historically in the U.S. chemical demilitarization facilities is considered very optimistic. At the off-site locations, each of these units will only be tested individually using partial monitoring and control systems (MCS) and utility interfaces. Each of these MCSs and utility interfaces will have specific differences from the utility inputs and FCS/FPS designed interfaces at PCAPP, requiring recertification of the units on-site. The assumption that many systems will be dropped into place and connected with minimal integration problems is not realistic. More importantly, since the number of systems at PCAPP is significantly more than baseline, and many of these systems have a high degree of complexity, additional time must be added to the baseline systemization average. These two major competing factors would mostly offset each other. Another factor favoring a reduced systemization period is that PCAPP has only one type of munition (projectiles) to systemize during IPRs, while the four baseline sites had three sequential IPRs for bulk items, rockets, and projectiles. The impacts of all the other remaining factors listed in Appendix A on page 150 should be nominal and collectively result in a neutral outcome.

Mitretek deducted [redacted] from the baseline average to account for the modular construction and testing of PCAPP process units and deducted an additional [redacted] for only having one IPR. Conversely, [redacted] were added to the baseline average to account for the increased number and complexity of PCAPP process units. Thus, given the historical data for the baseline facilities and the factors discussed, Mitretek's most likely point estimate for total systemization time is [redacted], or [redacted] of pre-systemization followed by [redacted] of formal systemization. This [redacted] period compares well with the historical baseline average of [redacted]. This estimate also compares well with the IGCE of [redacted] for the total systemization period, though the Mitretek estimate shifts the total systemization period forward in time by [redacted].

For the pessimistic estimate, the same factors are relevant, but adverse conditions could increase the magnitude of their impact. Given the major risks involved with systemizing the numerous unit operations alone and in parallel and acknowledging that much of the proposed systemization schedule depends on proper construction and testing of these units offsite (which has never been accomplished before in a major chemical demilitarization program), a pessimistic point estimate for total systemization is [redacted] (or [redacted] of pre-systemization followed by [redacted] of formal systemization). This pessimistic estimate also takes into account greater delays due to external events like lack of skilled workers affecting staffing, environmental permitting delays, and uncertainties in surrogate testing requirements.

3.1.2 Operations

For this analysis, the PCAPP operations schedule has been determined using Mitretek's engineering judgment based on experience with operations schedules of baseline CDFs and involvement in detailed design reviews for PCAPP. Historical planned and actual schedule durations of JACADS, TOCDF, and other sites were examined. End of campaign reports from JACADS (RE&C 1997a, 1997b, 1998, 1999a, 1999b, 2000a, 2000b, 2000c) and TOCDF (EG&G 2002) were used as available. Mitretek also reviewed the operations analyses and predictions in the Operations Task Force 2000 Report (PMCSD 2000) and the Operations NAS Review report (WDC 2001).

Mitretek reviewed and used CDF operating data that it had collected from JACADS and TOCDF in the 1996 to 2001 time period. Mitretek also used information derived from the reliability, availability, and maintainability (RAM) assessments of CDF munitions campaigns it had previously performed for the Project Manager for Chemical Stockpile Disposal (PMCSD) to better plan ongoing and future operations (Mitretek 1998, 1999, 2000a, 2000b). The RAM assessments included the development of a discrete event simulation model for the CDF that used actual operational data. Scoring conferences with Mitretek, PMCSD, AMSAA, and others were held to classify, verify, and modify, if necessary, the data to allow calculation of required system reliability parameters and cycle times for selected operational time periods.

A discrete event simulation model of PCAPP was developed by BPT using iGrafx®[1] Process 2003 software to help develop estimates for operations schedules in support of its design efforts. Since this model was not initially ready for use in this study, Mitretek developed a spreadsheet model to calculate estimated operations schedules. Rough verification of the spreadsheet model was done by replicating BPT's [redacted] operations duration using Intermediate Design data and assumptions. Because the static spreadsheet model cannot fully replicate PCAPP behavior (especially interactions and buffer behavior), Mitretek also made use of BPT's iGrafx process model after certain modifications were completed and tested. The capabilities and limitations of these two types of models are described in detail in Appendix D on page 155.

During this study, Mitretek had an opportunity to examine in some detail the iGrafx PCAPP model. Although some limitations and simplifying assumptions are discussed in Appendix D, Mitretek believes that the model is a reasonable representation of PCAPP behavior; especially for the 3-line configuration, which Mitretek spent the most time reviewing. Mitretek was not able to obtain a copy of the iGrafx model code for a detailed verification and validation (V&V);

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[1] iGrafx® is a registered trademark of iGrafx, a division of the Corel Corporation,

therefore, Mitretek cannot ensure that the model is completely free of all problems or "bugs" which could potentially affect the model results presented in this report.

Mitretek used its spreadsheet model as the primary source of operations durations in this analysis because of its ability to provide quick results for various scenarios. The iGrafx model was used to confirm the spreadsheet results, determine which systems were rate-limiting, examine buffer area behavior, and determine ranges for schedule estimates due to random statistical variability.

3.1.2.1 Factors Affecting Operations Schedule

Duration and Processing Restrictions

The BPT Statement of Work (SOW) defines duration and processing restrictions for some operations phases. A slow ramp-up to full operations rate is specified. During this initial [redacted] Shakedown/Ramp-Up period, PCAPP is to operate about half of the time at about half of the average expected rate (when operating). Thus, the facility will process an average of about 25% of expected sustained throughput (including unscheduled failures and scheduled downtimes) during this time period—assumed to be [redacted] by BPT. This slow ramp-up is needed to fix unforeseen problems that arise when agent processing begins at a facility. Although systemization will catch and solve many problems and demonstrate system and integrated facility performance, it is inevitable that some problems will not appear until actual agent operations begin. This slow ramp-up is consistent with the planned first campaign for baseline incineration facilities (usually GB rockets). At baseline CDFs, planned subsequent ramp-ups for projectile campaigns are much quicker (e.g., an [redacted] period) (PMCSD 2000; WDC 2001). Most CDFs also assume that the staffing of multiple shifts is also ramping up during this initial period. In contrast, PCAPP is currently planning to be fully staffed on all shifts on the first day of operations, thus providing additional confidence that the projected rates can be met (estimates may be conservative in this area).

The total duration of Pilot Testing—which includes shakedown/ramp-up, followed by performance testing, and followed by post-pilot processing while waiting for regulatory approval and Milestone III decision to continue with full Operations—is estimated to take place over a [redacted] period. Figure 3-2 on page 57 shows these operations phases graphically. Note that post-pilot testing is usually included as one of the phases within Pilot Testing. In addition, discussions of the overall schedule or cost of an "Operations Phase" in this report refer to the entire period of agent operations, not the full-rate operations period after the post-pilot testing.

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Figure 3-2 –Agent Operations Phases

The SOW requirement for Pilot Testing, "*All systems shall be demonstrated during this period*" (RFP 2002 §5.1.4.1), is unclear as to whether all systems (e.g., as PMD, MWS, ERH, ICB) are to be tested with possibly only one munition type, or whether all munition types need to be demonstrated under a variety of conditions as well. BPT's initial assumption is that *all three* types—105-mm projectiles, 155-mm projectiles, and 4.2-inch mortars—will need to be processed with some type of regulatory oversight and examination of performance testing data. The concurrent processing of one munition type in each ECR allows PCAPP to provide this performance testing without additional tooling switchovers. If PCAPP processed the same munition in all ECRs (as was done at JACADS), additional time for tooling switchovers and additional costs for tool sets would be needed.

Post-pilot restrictions (half-peak throughput) are assumed by BPT to be imposed by regulators while they are examining performance data. Although details of performance testing and any post-pilot restrictions have not been developed or agreed upon by BPT and Colorado regulators, half throughput was imposed by regulators at demilitarization sites such as TOCDF. ANCDF processes at half rate for about [redacted] until performance data (trial burn data) is received by the state regulators; then they have approval to process at three-quarters rate until final permit approval. Therefore, the assumption of half-rate is reasonable but may be conservative.

PCAPP Throughput Assumptions

PCAPP throughput is determined by a combination of the peak speed at which the rate limiting systems of the facility will process and the availability of the systems to process. Systems are unavailable when they are being repaired following an unscheduled failure or are down due to a scheduled downtime for activities such as preventive maintenance. Peak throughput rate multiplied by the combined availabilities of the coupled rate limiting systems will provide an average throughput rate. This average throughput rate combined with any processing restrictions (e.g., reduced rates during ramp-up) determines throughput during various portions of the PCAPP operations schedule.

Throughput: For different systems, BPT defines *Normal Throughput Rates* as the peak rates that can be sustained for long time periods and *Peak Throughput Rates* as [redacted] of the Normal Throughput Rate that can be sustained only for short time periods.

Some redundant and spare units are included in the facility to help ensure high throughputs. For example, each MWS has an online spare CAM that can be immediately put in service if a CAM fails during operations. It would thus take two CAM failures to shut down an MWS.

BPT assumed that the PMD is the rate-limiting system. BPT has significantly redesigned the PMD to take advantage of much newer technology and ensure the availability of spare parts, as well as to improve reliability over what has been experienced at baseline CDFs. The new design includes a robot instead of a rotary turntable and redesigned munitions processing stations. BPT estimated peak rates using engineering judgment and examination of mainly JACADS processing rates (TAA 2004). BPT's estimate of [redacted] for PMD availability is significantly higher than what has been demonstrated for previous PMD operational campaigns.

Concurrent Processing: PCAPP is designed for concurrent simultaneous processing of three munition types (variations of this concept are called coprocessing or complementary processing at CDFs). Proper planning, design, and staffing are needed to avoid reductions in assumed throughputs. PCAPP has been designed to process in this manner with dedicated processing lines (e.g., PMD to MWS to MPT). In contrast, when TOCDF began complementary processing, they had issues to overcome during operations, such as determining how to sequence projectiles and bulk items through the same metal parts furnace, retrofitting the control system to allow the processing of previously unallowed combinations of munitions, and trying to ensure maintenance crews were proficient in the maintenance and repair of all types of systems (e.g., projectile, rocket, and bulk item) during the same time period. BPT has reportedly planned for potential difficulties, such as adding some additional control room workstations to handle the additional operations required.

Processing of HT mortars along with HD 155-mm projectiles (concurrent processing on two or three lines) is advantageous in the neutralization chemistry that has been shown in the laboratory to require a dilute HT mixed in HD. The proper dilution ratio may be difficult to achieve if mortars (even a combination of HD and HT mortars) are processed during a single munition campaign. In addition, there is no ability to store the HD or HT separately in the facility in order to control the mixture ratio in the ENRs. A ratio of about 19:1 HD to HT has been successfully neutralized during neutralization tests, while a ratio of about 2:1 has shown some promise during testing. At this time, the more dilute the HT, the better the performance.

PCAPP has been designed to process all dunnage and secondary waste (except for spent carbon) during operations. In contrast, some large waste streams, such as used DPE suits, are processed during closure at baseline facilities. The dedicated PCAPP DSH and CSTs have been sized to handle the expected waste throughput rate so they will not become rate limiting in the facility. The MPTs have also been designed with additional capacity to be able to handle the expected waste throughput rates without impacting munitions processing operations.

Equipment Switchovers: BPT assumes that it will take about [redacted] for equipment tooling switchovers between projectile types. This time period, which is consistent with baseline CDFs (WDC 2000), actually includes about [redacted] of tooling installation/testing and about [redacted] of ramp-up. The processing scheme of concurrent processing minimizes the number of tooling changeovers. Since all munitions have mustard agents, no lengthy agent changeovers ([redacted] for baseline) are needed.

3.1.2.2 Mitretek 3-Line Base Case – Most Likely

Throughput Assumptions

It is assumed that lessons learned from baseline incineration and neutralization facilities will be implemented at PCAPP. Relevant similar operations and maintenance activities at PCAPP will benefit from years of experience with the processing of munitions and agent at other facilities.

Mitretek agrees that the PMD should be assumed to be the rate-limiting system. The PMD is closely coupled to the ETS, ERH, and HDC systems and their associated support systems. Efforts should focus on keeping munitions flowing from the UPA to the PMDs and downstream systems. This will be evidenced by little idle time for PMDs. Many of the campaigns at JACADS and TOCDF had significant time periods where the PMDs were idle waiting for munitions, blocked by downstream systems such as the deactivation furnace system (DFS) failures, or deliberately directed to delay processing.

Although much of the PMD is redesigned and modified, its functionality is expected to be similar to that used at baseline CDFs. BPT has specified "Normal" processing rates of [redacted] for 155-mm projectiles and [redacted] for 105-mm projectiles and 4.2-inch mortars; "Peak" rates are [redacted] higher. The BPT assumed processing rates were determined to be reasonable based on engineering judgment of experience at JACADS and TOCDF. Mitretek reviewed campaign reports from JACADS and TOCDF. Mitretek reviewed an operational assessment and planning report written by PMCSD and contractor operations experts (PMCSD 2000) and the Operations NAS Review (WDC 2001), which provides campaign schedules for planning purposes for ANCDF and other Washington Group demilitarization sites. Mitretek also reviewed data it had collected and scored from JACADS and TOCDF in the 1996 to 2001 time period. Normal rates specified by BPT have been demonstrated on a sustained basis. In fact, peak rates have been demonstrated at some times. Rates for 105-mm projectiles have been observed to be above [redacted] and rates for 155-mm projectiles have been observed to be above [redacted].

Mitretek reviewed PCAPP facility and equipment availability based on engineering judgment of experience at JACADS and TOCDF and examination of scored data as discussed. Mitretek believes that many BPT assumed system availabilities are optimistic. Even with the improvements noted, Mitretek does not expect the PMD to achieve [redacted] availability. Campaign reports show typical availabilities are [redacted] for the original PMD. Mitretek adjusted its scored data for a typical projectile campaign to estimate what availability could possibly be expected in the new PMD design. Failures and downtimes were deemed non-relevant if they were attributed to equipment that will not be present in PCAPP, such as the burster size reduction machine, DFS feed gates, the turntable, and hydraulic-related systems (most of which will be eliminated). When these are removed, a new PMD availability was estimated to be about [redacted] for the portion of the campaign examined. Additional new failures from PMD-related systems new to PCAPP will also undoubtedly occur, lowering the calculated availability. While Mitretek recognizes that the PCAPP PMD should perform better than what has been demonstrated, it believes a [redacted] availability cannot be justified at this time.

In order to obtain more realistic (lowered) availabilities, Mitretek adjusted failure and downtime parameters on the equipment level based on previous experience with system reliability behavior of baseline CDFs. This also allowed easier direct input into the BPT PCAPP iGrafx simulation model when used. Previous reliability parameters from scored data were used as a guide; however, differences in the level of modeling detail and definitions of failures/downtimes prevented direct application of the previous data. Mitretek availabilities (including failure and downtime parameters) are provided in Appendix D. For the PMD, the availability was estimated to be [redacted] based on the reasons discussed above.

The ETS system design has not been finalized; however, the [redacted] availability quoted in the TAA was thought to be optimistic for either the monorail or the pneumatic tube system. Thus, an availability of [redacted], closer to availability for other moderately complex mechanical systems such as the HDC or MWS, was thought to be more realistic. The HDC and ERH availabilities were adjusted (reduced) to incorporate the effects of maintaining or repairing major HDC and ERH support equipment. New parameters were calculated by considering the reliability data contained Table 2-1 of the Intermediate Design calculation document "*Basis of Maintenance Info for Throughput Analysis*" (PCAPP IDP 24852-M4C-000-B0004).

An overall equipment availability was determined (through a joint probability calculation) by multiplying the availabilities of the rate limiting coupled equipment on the critical path (PMD/ETS/ERH/HDC). This estimated overall equipment availability was calculated to be [redacted] to [redacted], reduced from BPT value of [redacted]. Note that BPT's determination of overall equipment availability is based on data obtained from running the model at full rate throughput with 1 year's worth of munitions. Schedule calculations for the IGCE reduced the BPT overall equipment availability to about [redacted].

For the simulation model, all reliability parameters were assumed by BPT to have normal statistical distributions. Based on Mitretek's experience with operations data from CDFs, repair times often have lognormal distributions. A lognormal distribution is often more valid for a time data set that has a "long tail" when the probability density function is plotted. In other words, in data that have lognormal distributions, there are a few time values many times greater than the average value. One typical use of a lognormal distribution is to represent the time to perform some task such as equipment repair. For all Mitretek simulation model cases, lognormal distributions (with a typical standard deviation twice the mean) were used for all system repair times. This allows very long repair times to show up during model runs, "stressing" the model as would occur in the actual facility. The outcome is more variability in model results when multiple replications are performed.

Historical information and data were also examined to determine if [redacted] of downtime (leading to [redacted] availability) due to external factors was consistent with what has been experienced in baseline facilities. Based on previous scored data on plant-wide failures and downtimes, an availability of [redacted] from plant-wide and external factors was assumed. Major shutdowns due to unlikely but possible external events were not considered because it is difficult to reliably estimate their probability of occurrence and the resulting effect on operations schedule. These low probability events include agent release, safety shutdown due to major injury, change in regulations, unusual munition/agent condition/composition (e.g., heavy metals in agent), litigation or public protests, weather catastrophe, etc.

Concurrent Processing

Mitretek examined whether the facility designed for concurrent processing of three types of projectiles/mortars could be accomplished without adversely affecting throughputs. Two recent government plant managers of TOCDF were contacted to determine their opinion on complementary processing at TOCDF. Mr. Tim Thomas was plant manager during the GB campaign, and Mr. Dale Ormond was plant manager during part of the VX campaign. Mitretek also examined its previous scored data for selected time periods at TOCDF. During a 2-month time period in 2000, there was simultaneous processing of GB energetic 105-mm projectiles, non-energetic 105-mm projectiles, gelled rockets, and ton containers. The processing focus was on projectiles, and TOCDF was able to maintain a typical relatively high throughput through one ECR. Rockets and ton containers were processed at slower rates. During the VX campaign, there were problems with sequencing entries and with keeping all maintenance crews proficient in all types of repairs. In fact, complementary processing was stopped at some point in order to focus on a single munition type.

Mitretek believes that concurrent processing of three munition types is feasible. However, the presence of the third line (regardless of what it is processing) results in an increased demand for maintenance and repair activities. DPE entries must be sequenced appropriately and there must be enough trained staff that are medically cleared (sufficient time between entries), as well as support staff needed to monitor the entries. The maintenance and repair of systems for three types of projectile tool sets may be slightly more difficult for than a single projectile type, but it should be considerably easier than what was required when processing projectiles, rockets, and bulk items at TOCDF. Because of potential conflicts and delays in DPE entries, a [redacted] delay time was added to repair systems in the EPB and APB. For example, the average time to repair the PMD and restore it to full operation was estimated to be [redacted] based on engineering judgment and historical experience with a 2-line facility; this time was increased to [redacted] when a 3-line facility is evaluated. It was judged that this delay time would not be necessary for scheduled maintenance because there would be more opportunity to postpone these events to less busy time periods. A delay of more than [redacted] was not added because it is possible that entries can be made in Level C PPE instead of Level A DPE for areas that have never been contaminated.

The destruction of secondary waste and dunnage during operations using the DSH, CSTs, and MPTs is not on the critical path and should not affect the munitions throughput rate. Therefore, Mitretek assumed no adverse affect on the munitions processing operations schedule.

Reject and Leaker Processing

Both liquid and vapor leakers are present in the PCAPP stockpile and more are expected to be discovered during continued storage and processing. Mitretek did not change the expected numbers or processing rates that are provided in the TAA. Mitretek believes that the leaker processing rates of [redacted] of normal throughput for vapor leakers and [redacted] for liquid leakers are reasonable.

Rejected munitions (called “rejects”) are generated at the PMD due to the inability to successfully process a munition at all stations (NCRS, MPRS, and BRS). Usually the nose closure (lifting plug) is the component that cannot be removed. PCAPP will use a gimbaled cam socket (GCS) fixture to remove nose closures, as was successfully done at during the JACADS 155-mm VX projectile campaign, where the reject rate was only [redacted], a significant improvement over what was seen with the original hydraulic chuck fixture system. Although the 155-mm mustard projectiles are the same size as the 155-mm VX projectiles, they have notably different hardware configurations and come from different manufacturing eras. The mustard munitions should be easier to disassemble because the threads are “looser” than those on VX munitions, suggesting that there could be an even lower reject rate. However, during the processing of 155-mm GB projectiles at TOCDF, the reject rate was about [redacted] (EG&G 2002). Mitretek assumes that for the 155-mm projectiles, a most likely rate of [redacted] is appropriate. Even though the GCS has not been used on 105-mm projectiles or 4.2-inch mortars (the original system demonstrated a higher reject rate of [redacted]), BPT assumed a [redacted] reject rate for all three types of munitions because a GCS will be used to process all types. Mitretek believes that a [redacted] reject rate for munitions that have not been demonstrated with this tooling is optimistic. Therefore, an average of [redacted] was assumed for 105-mm projectiles and 4.2-inch mortars.

The rate of reject processing at TOCDF and JACADS is highly variable and depends on their condition, as well on the numbers of rejects to be processed. Processing rates can be as slow as a few per day if very few are present to several per hour if a long campaign results in lessons learned on how to process rejects rapidly. Mitretek assumed a reject processing rate of [redacted].

Rejects and leakers will be processed on one line in dedicated sequential campaigns at the end of normal operations campaigns (additional switchovers are needed) due to Army regulations about concurrent processing and DDESB discussions with BPT (TAA 2004). BPT acknowledges in the TAA that this change will be made in their final design schedules. Mitretek assumed that a [redacted] tooling switchover is needed following normal campaigns to install the reject cutter tooling and other needed equipment.

Input Data

Input data used to calculate operations schedules are provided in Table 3-2 on page 63 and Table 3-3 on page 63.

Table 3-2 – Input Parameters Common to All Cases

Factor	4.2-inch Mortars	155-mm Projectiles	105-mm Projectiles
Normal Rate (munitions/hr)	[redacted]	[redacted]	[redacted]
Number of Munitions	[redacted]	[redacted]	[redacted]
Number of Leakers	[redacted]	[redacted]	[redacted]

Table 3-3 – Input Data for 3-Line Most Likely

Factor	4.2-inch Mortars	155-mm Projectiles	105-mm Projectiles
Equipment Availability Factor*	[redacted]	[redacted]	[redacted]
Plant Availability Factor	[redacted]	[redacted]	[redacted]
Number of Rejects	[redacted]	[redacted]	[redacted]

** - Used in spreadsheet model—reliability parameters for the iGrafx model can be found in Appendix D on page 155.*

3.1.2.3 Mitretek 3-Line Base Case – Pessimistic

Most assumptions were the same as for the 3-line most likely case. Availability parameters were reduced for the coupled rate limiting systems to allow for the potential for additional problems with operating and interfacing first-of-a-kind (FOAK) equipment. For example, the PMD was assumed to have an availability of about [redacted]. Parameter modifications result in a combined equipment availability of [redacted]. These availabilities include an increased DPE delay time of [redacted] for this 3-line pessimistic case. The overall plant-wide and external event availability was reduced to [redacted] to correspond with some values seen from JACADS and TOCDF when plant operations had additional delays. The numbers of rejects are assumed to be twice the amount predicted for the most likely case for all types of munitions to allow for lot-to-lot variations which could produce unknown difficulties at the PMDs.

Table 3-4 – Input Data for 3-Line Pessimistic

Factor	4.2-inch Mortars	155-mm Projectiles	105-mm Projectiles
Equipment Availability Factor	[redacted]	[redacted]	[redacted]
Plant Availability Factors	[redacted]	[redacted]	[redacted]
Number of Rejects	[redacted]	[redacted]	[redacted]

** - Used in spreadsheet model—reliability parameters for the iGrafx model can be found in Appendix D on page 155.*

3.1.2.4 3-Line Base Case Results

The base case 3-line "most likely" estimate for operations schedule from the spreadsheet model is [redacted]. This includes all pilot testing plus subsequent full operations. Figure 3-3 on page 65 shows a representation of the order of campaigns. Adding additional risk to the 3-line most likely operations schedule results in a schedule of [redacted], an increase in [redacted] to the schedule for the pessimistic case.

Various scenarios were examined to determine the major reasons that the schedule durations are longer than the IGCE/BPT estimates. The [redacted] difference between the IGCE estimate and the most likely estimate is comprised of about [redacted] for processing leakers and rejects at the end of campaigns rather than in-line at the completion of each campaign, about [redacted] due to lowered availabilities, and about [redacted] due to a larger assumed number of rejects and slower leaker and reject processing rates. When comparing the most likely estimate to the BPT estimate, the difference in availabilities is responsible for about [redacted] of the difference while the other factors stay about the same as above.

The iGrafx model produces a most likely operations duration of approximately [redacted], which is very similar to the duration obtained from the spreadsheet model. A set of 30 model replications with different random number seeds shows about a [redacted] range due to statistical variability (random occurrences and durations of failure and maintenance events). Thus, hypothetically, if the plant runs it campaigns 30 times, the overall operations duration would average about [redacted], but could be as short as about [redacted] and as long as about [redacted].

The simulation model output shows that the PMD (combined with coupled systems) is rate limiting for the facility. The PMDs have the highest utilization (least idle time) during operations. The model output also shows that the CSTs are highly utilized but they are not a bottleneck. The model also shows idle times for the MPTs during which they could be used to process secondary waste (which is not currently modeled). An examination of buffer area behavior shows that buffers appear to fill appropriately during peak processing and when long failures/downtimes occur.

For the pessimistic case, the iGrafx model produces an average of about [redacted] with a range of about [redacted]. This [redacted] variation from the spreadsheet model is not considered significant.

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Figure 3-3 – 3-Line "Most Likely" Campaign Schedule

3.1.3 Closure

Closure of the PCAPP facility will benefit directly from the experience and lessons learned already achieved at JACADS, as well as from the closure experiences of additional CDFs prior to the time for PCAPP closure. The types of activities to be undertaken during PCAPP closure (e.g., general area decontamination, equipment removal, thermal treatment, area monitoring, and testing) are the same as those conducted at an incineration facility.

One of the potential cost drivers for closure of a CDF is the scabbling and thermal treatment of contaminated concrete. At the beginning of the JACADS closure process, there was no approved test method in place to determine the presence (or absence) of chemical agent in concrete; consequently, early closure plans for JACADS called for extensive scabbling of the floors in Category A and B areas to conservatively address the issue. In the course of the JACADS closure effort, a reliable laboratory technique was developed for determining the presence of chemical agent in concrete, and the method was approved by the EPA. Consequently, significant portions of Category A and B areas that were never exposed to liquid contamination will likely be chemically decontaminated and tested to confirm that agent is not present in the concrete at levels above regulatory concern. The experience at JACADS indicated that all areas that were subject to only vapor contamination could be chemically decontaminated to levels below regulatory concern. Scabbling will still be required at PCAPP in areas where liquid agent contamination is likely, such as around the MWS, the ACS, and the ANS. However, even though the PCAPP design incorporates approximately 90,000 ft^2 of floorspace in Category A and B areas compared to only 35,000 ft^2 of corresponding space for baseline incineration, the overall amount of scabbling likely to be necessary to be performed at PCAPP is less than what was actually performed at JACADS.

In terms of floorspace, the APB, EPB, and CSB at PCAPP are collectively about 3.7 times the size of equivalent baseline incineration facilities, but only 2.6 times when considering only the Category A & B areas. The nature of baseline incineration accessing equipment, the rocket shearing machine (RSM) and Multipurpose Demilitarization Machine (MDM) has resulted in significant contamination of those operating areas. During rocket shearing, residual agent heel and sometimes undrained rockets fall onto the hot lower blast gate leading to the Deactivation Furnace System (DFS). This results in combined agent and water vaporization that forms a plume into the ECR, greatly increasing contamination of the equipment, structure, and HVAC. The rocket process also requires significant washdown with decontamination solution before entries, further soaking the room. Unexpected contamination also occurs at the MDM Pull and Drain Stations (PDSs) due to munition anomalies. Because of overpressure in some mustard and GB munition, agent has sprayed out into the process room. Due to early problems with the PDS at JACADS, many burster wells—which are agent-coated—had to be dropped onto the floor rather than reinserted, resulting is further contamination of the room. The problems at the MDM also resulted in extensive decontamination washdowns for maintenance entries. Finally, in baseline, transfer of chemical munitions through the facility is much more conducive to liquid agent contamination in rooms, elevators, conveyors, corridors, and staging areas than the PCAPP design, which will use airlock conveyors. The aforementioned pathways for increased contamination will not be present at PCAPP.

A significant lesson learned from JACADS was the benefit of processing as much waste material as possible during the operations phase, avoiding the accumulation of significant amounts of waste to be processed as part of closure activities. This philosophy has been incorporated into the PCAPP "total solution" design. The DSH system will be used to process waste materials (e.g., used DPE, rags, dunnage, etc.) as they are generated. The one exception is contaminated carbon removed from filter units, which will be placed in drums and processed separately at the start of closure operations. Since there is likely to be more contamination in the carbon than in the other waste streams, accumulation of the carbon for later processing will allow the DSH equipment to operate in a cleaner status during operations, with less possibilities of accidental exposure to workers.

The approach for estimating the duration of closure at PCAPP is through the comparative method of estimating. Using the JACADS experience as a baseline,[1] factors are considered for PCAPP that differ from JACADS, and adjustments are made to yield the PCAPP closure estimate. Based on this process, the most likely closure duration estimate for PCAPP is [redacted], with a pessimistic estimate of [redacted]. Additional detail on these estimates is provided below. The JACADS facility began closure operations on [redacted]; demolition of the MDB was completed by [redacted], yielding a closure duration of [redacted]. The initial closure estimate for JACADS was [redacted].[2] The primary factors that affect the PCAPP closure duration relative to the JACADS experience are building sizes and design, amount of machinery, incorporation of closure lessons learned into the plant design, closure equipment redundancy, and external factors.

As indicated above, even with the additional size, the amount of scabbling of concrete surfaces to remove contaminated concrete is expected to be less at PCAPP than at JACADS due to the establishment of an approved technique for determining the presence of chemical agent in concrete. For example, the EPB is almost the same size as the APB, but unless there is inadvertent liquid contamination during the course of operations, there is not expected to be any scabbling required at all in the EPB. For areas that do need scabbling, demilitarization sites performing closure in the continental United States are anticipating increasing the rate of DPE entries by 33% above what was authorized for JACADS, thus allowing these operations to proceed at a greater pace. Still, the larger plant size will require additional effort for chemical decontamination of areas subject to vapor contamination and subsequent clearing of the space as being at levels below regulatory concern, with a net estimate of an additional [redacted] of closure duration. With the single story facility design for PCAPP, there is no opportunity for leakage on the second floor migrating through floor joints to the first-floor ceiling, requiring additional decontamination. This will reduce the closure schedule by [redacted].

In evaluating the systems present in the PCAPP design vs. the JACADS facility, there are about 60% more major systems in the PCAPP plant. Assuming that [redacted] of the closure time is associated with the removal of equipment, this would result in an increase of [redacted].

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[1] PMCD "Program Manager for Chemical Demilitarization, CONUS Closure Estimate" draft, December 2002

[2] Raytheon Demilitarization Company, "JACADS Closure Campaign Planning Documents" Final Draft, June 1999.

Lessons learned at JACADS were incorporated into the PCAPP design for closure. The use of modular, skid-mounted equipment will ease the equipment removal process, and the MPTs have been designed specifically to be able to accommodate the largest of the skid-mounted equipment. Tanks and equipment have been located within the plant to minimize the potential for cross-contamination to other systems and to minimize the extent of HVAC ducting that might be expected to become contaminated during normal operations. Additionally, leakers will be frozen prior to processing during the leaker campaign and will only be processed in one ECR, thus limiting the potential for contamination and subsequent cleanup. These features would reduce the schedule relative to JACADS by a [redacted] duration.

While there will be more equipment to be removed and processed at PCAPP, the design incorporates much more redundancy and capacity into the closure process than at JACADS. There was only one Metal Parts Furnace (MPF) at JACADS to process closure wastes, while there will be three MPTs at PCAPP, although the treatment capacity of the MPF is very high. During JACADS processing, there were periods where up to [redacted] supply of closure wastes were staged in the hydraulics room awaiting the availability of the MPF. In addition to increased availability, there will also be increased capacity to perform early closure of those systems whose mission has been completed during the tail end of the operations phase. The increased redundancy and capacity to process closure materials will result in a [redacted] reduction in closure duration.

Another lesson learned from JACADS closure is that it is better to process closure wastes as they are generated rather than to accumulate the wastes and process them during closure operations. At PCAPP, the DSH system will be utilized to process waste materials (e.g., used DPE, rags, and dunnage) as they are generated. The early processing of these materials is expected to reduce the closure duration relative to JACADS by [redacted].

The closure process is subject to external influences just the same as for the other life cycle phases. The greatest potential impact is the possibility of changes in environmental regulatory requirements between now and when closure actions are undertaken. Given that the current technique for determining the presence of chemical agent in concrete was only recently approved by the EPA, significant difficulties in getting the technique approved in Colorado prior to the start of closure operations is not anticipated. A delay of just [redacted] was assessed to account for these potential external influences.

Collectively, the factors discussed above result in a reduction of [redacted] in the [redacted] closure duration achieved at JACADS or a most likely closure duration estimate of [redacted] for PCAPP.

For the pessimistic estimate, the same factors are relevant, but adverse conditions could increase the magnitude of their impact. One major factor impacting the closure duration would be the consequences of experiencing significant instances of liquid agent contamination within the facility during the operations phase. This would increase the amount of area that would have to be scabbled to remove contaminated concrete, as well as increase the amount of samples that would have to be taken and tested to confirm that these and adjacent spaces are at contamination levels below regulatory concern. The experience at JACADS was that the environmental regulators wanted more samples taken in those areas where the likelihood of finding contamination was the greatest. Given the large size of the Category A and B areas in the PCAPP facilities, the cleanup of excessive liquid contamination were it to occur could add an additional [redacted] to the closure schedule.

In the most likely estimate, a reduction of [redacted] was taken to account for the increased redundancy and capacity of systems to process closure wastes during closure. If the rate of generation of these wastes is not as great as the throughput capacity of the 3 MPTs, it may not be possible to fully take advantage of these gains in reducing closure duration. Under the pessimistic scenario, these gains are reduced in half for a [redacted] reduction, or a net increase in duration of [redacted] relative to the most likely estimate.

For external factors, a most likely delay of [redacted] was assessed to account for the potential impact of changes in environmental regulatory requirements between now and when closure actions are undertaken. If there are significant changes in what levels of contamination constitute being of regulatory concern, the delays associated with meeting and confirming compliance to these new standards could be greater. Consequently, the pessimistic assessment of these potential external influences would increase by [redacted] to a [redacted] delay.

Additional factors such as the single-story building design or the use of modular equipment to facilitate closure operations are not particularly sensitive to change under a pessimistic scenario. Therefore, pessimistic assumptions taken collectively could lead to an increase in closure duration of [redacted] above the most likely closure estimate for PCAPP, or a total duration of [redacted].

3.1.4 Summary of Schedule Adjustments for the 3-Line Base Case

Table 3-5 – Adjusted Schedule for Most Likely 3-Line Base Case

Life-Cycle Phase	Duration (months)
Systemization	[redacted]
Operations (including Pilot Testing)	[redacted]
Closure	[redacted]

3.2 2-Line Alternative

The estimated schedule for construction, systemization, operations, and closure is presented below for the base 2-line process. The 2-line process with offsite waste disposal is discussed in §3.3.

3.2.1 Construction

The IGCE of the construction time for the 3-line process is [redacted]. In Mitretek's view, the length of time to construct the 2-line facility discussed in §2.3.1 on page 29 will not be considerably different from that of the 3-line process. While the difference in the facility size should not have a significant impact on the schedule for constructing the buildings themselves, the sequential nature of installation of process equipment after the building shell is completed (e.g., installing the modules, mechanical alignment of modules, electrical power, instruments and controls [I&C], other utilities, etc.) will affect the total construction time. For the 2-line process with or without offsite disposal, it is estimated that the equipment installation will be completed about [redacted] sooner than that for a 3-line process because there will be less equipment to install. Thus, for the 2-line without offsite disposal alternative, the most likely estimate for construction duration is [redacted]. Consistent with the approach adopted for the 3-line process schedule analysis, no pessimistic estimate is provided for the 2-line without offsite disposal case.

The estimated construction duration takes into account the relative reduction in the number of craftsmen, technicians, and engineers needed during construction. Mitretek did not think it prudent to assume that the workforce will be increased to further cut construction time. There is a shortage of skilled people at chemical demilitarization facilities, and PCAPP will not be an exception. Building a smaller and less complex facility will improve the chances that the facility will be constructed without considerable delay even with the limited number of craftsmen, technicians, and engineers available.

3.2.2 Systemization

For the 2-line process, the estimation of a most likely value is straightforward. All of the negative or schedule-increasing factors are still relevant but with less impact since there are fewer pieces of equipment. Clearly, if all other things are equal, less equipment should result in a shorter systemization period.

Mitretek's 2-line process alternative, discussed in detail in §2.3.1 on page 29, indicates the specific processing equipment that would be removed from the 3-line process design. It should be noted that elimination of one of three processing lines does not equate to one third of the total equipment. Although floorspace savings can be represented in percentage, the same is difficult for equipment savings. However, as presented in §2.3.1 on page 29, the ROM reduction appears to be about 12.5% in the number of major process units.

The frequency and proportion of two types of errors, random and systemic, impact the time required for systemization troubleshooting and repair. Random errors are those resulting from expected craft labor mistakes in installation and connection of the process units. Systemic errors are those due to design errors and integration problems and will be common to identical pieces of equipment, requiring identical design changes. While a reduction in random errors is directly based on fewer pieces of equipment for the 2-line case, there will be no reduction in systemic errors since no one type of equipment is completely removed. Numerous random errors are expected for a plant such as PCAPP with so many new pieces of equipment requiring extensive integration. While skid-mounted unit operations are expected to have a reduced amount of problems due to the extensive offsite functional acceptance testing, many systemic errors will not be encountered until on-site integration begins.

Mitretek's assessment is that a [redacted] reduction, or a [redacted] total systemization period, could be realized with the 2-line process (the [redacted] overlap with construction would stay the same, resulting in a [redacted] formal systemization period).

For the pessimistic 2-line estimate, the same factors are relevant, but adverse conditions could increase the magnitude of their impact. Given the major risks involved with systemizing the numerous unit operations alone and in parallel, and acknowledging that much of the proposed systemization schedule depends on proper testing of these units offsite, a pessimistic point estimate for total systemization is [redacted] (or [redacted] of pre-systemization followed by [redacted] of formal systemization). This pessimistic estimate also takes into account greater delays due to external events like lack of skilled workers affecting staffing, environmental permitting delays, and uncertainties in surrogate testing requirements.

3.2.3 Operations

Equipment and systems were removed as described in §2.3.1 on page 29, (e.g., there are 2 PMDs, 2 MWSs, 2 MPTs, etc.) Most assumptions were the same as for the 3-line case. One change is that on DPE entry, it is assumed that delay is not needed because there are fewer maintenance and repair activities needed and fewer potential conflicts. The order of campaigns is changed with 155-mm projectiles and 4.2-inch mortars being processed in the two ECRs at the start of operations. It is assumed that performance testing of 155-mm projectiles and 4.2-inch mortars is sufficient to prove the plant operation to regulators so that no performance testing of 105-mm projectiles is required.

Table 3-6 – Input Data for 2-Line Most Likely

Factor	4.2-inch Mortars	155-mm Projectiles	105-mm Projectiles
Equipment Availability Factor*	[redacted]	[redacted]	[redacted]
Plant Availability Factors	[redacted]	[redacted]	[redacted]
Number of Rejects	[redacted]	[redacted]	[redacted]

** - Used in spreadsheet model—reliability parameters for the iGrafx model can be found in Appendix D on page 155.*

The 2-line pessimistic case uses a combination of the new parameters for the 2-line most likely case and the 3-line pessimistic case. In addition, it is assumed that performance testing of 105-mm projectiles is required during the pilot demonstration phase. This results in one additional equipment changeover and some additional time for ramp-up and a demonstration test.

Table 3-7 – Input Data for 2-Line Pessimistic

Factor	4.2-inch Mortars			155-mm Projectiles			105-mm Projectiles		
Equipment Availability Factor*		[redacted]			[redacted]			[redacted]	
Plant Availability Factors		[redacted]			[redacted]			[redacted]	
Number of Rejects		[redacted]			[redacted]			[redacted]	

** - Used in spreadsheet model—reliability parameters for the iGrafx model can be found in* Appendix D on page 155.

3.2.3.1 2-Line Base Case Results

Modifying PCAPP to a 2-line facility results in a [redacted] operation duration for the most likely case. This is an increase of [redacted] compared with the 3-line most likely case. Figure 3-4 on page 73 shows a representation of the order of campaigns for this case. Adding additional risk to the 2-line most likely operations schedule adds [redacted] to the schedule in a pessimistic case ([redacted] estimate). The iGrafx model shows a most likely average of about [redacted] with a range of about [redacted]. As expected, the PMD coupled systems are rate limiting. For the pessimistic case, the average is [redacted] with a range of [redacted]. Although the iGrafx results are somewhat lower than the spreadsheet model results, the iGrafx model outputs show fewer failures than anticipated for some systems. This discrepancy could not be fully examined for this study, thus the results may need further verification.

3.2.4 Closure

The closure duration estimate for the 3-line process was determined in §3.1.3, on page 66, to be [redacted]. For the 2-line process, there are two primary factors affecting closure duration that have opposite impacts. Due to the smaller size of the facility and the reduction in processing equipment, there is less material that needs to be removed and thermally treated during the closure operation. Clearly, this would have the effect of reducing the effort required for closure activities. However, the 2-line process also incorporates having 2 MPTs instead of the 3 MPTs present in the 3-line process. In addition to treating metal parts during normal operations, the MPT also plays a critical role during closure in the thermal decontamination of equipment and materials removed during closure activities. To determine the net impact, the relative contributions of these two competing factors must be considered.

The 2-line process incorporates less space than the 3-line process, as described in §2 on page 13. The estimated amount of Category A area decreases from approximately 40,000 ft^2 in the 3-line process to 38,000 ft^2 for the 2-line, or a 5% reduction. Similarly, the amount of Category B space decreases from approximately 55,000 ft^2 to 45,000 ft^2, or an 18% reduction. These total area reductions also correspond to reductions in the areas that might be potentially contaminated by liquid agent during operations, and subject to time consuming scabbling activities as part of area decontamination activities (although only limited portions of the Category A and B areas are expected to see exposure to liquid agent during the operational life of the facility and thus require scabbling). For the most part, major processing systems such as the PMD, SDS, MWS, and MPT systems are expected to be reduced by one third from three units to two. However, many of these

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Figure 3-4 – 2-Line "Most Likely" Campaign Schedule

systems have associated with them off-gas treatment systems or ventilation ducting that—while they may be reduced in the 2-line process—are not likely to be reduced by one third. By considering the 5% reduction in Category A spaces, the 18% reduction in Category B spaces, the one third reduction in several major processing systems, and the limited reduction in supporting systems such as ventilation ducting and off-gas treatment, it was determined that the collective load of closure materials being treated by the MPTs would be reduced by approximately [redacted] in going from the 3-line to the 2-line process.

As indicated above, the 2-line process only has 2 MPTs in the design, a 33% reduction relative to the 3-line process. Even though the collective amount of closure material to be processed in the MPTs is reduced by [redacted] for the 2-line process, when coupled with the 33% reduction in MPT systems to perform the thermal decontamination, the difference of [redacted] represents an increased utilization required of the MPTs to complete closure operations. With closure for the 3-line process estimated to be [redacted], the [redacted] increased utilization will add an additional [redacted] to the closure schedule. Therefore, the most likely closure duration estimate for the 2-line process is [redacted].

For the pessimistic estimate, the factors identified in §3.1 on page 48 that might adversely impact the 3-line process were excessive liquid agent contamination and subsequent cleanup; inability to take advantage of the throughput capacities of the MPTs; and changes in environmental regulatory requirements. The potential for accidental liquid agent contamination and environmental regulatory uncertainties remain the same for either the 2-line or the 3-line process. However, for the 3-line process, it was determined that if the rate of generation of closure materials requiring thermal decontamination was not as great as the throughput capacity of the MPTs, then the benefit of equipment redundancy may not be fully realized, so a [redacted] impact was assessed. For the 2-line process, it is much less likely that the generation of closure wastes will not keep pace with the throughput capacity of the 2 MPTs, so that the [redacted] impact is not appropriate in this case. Overall, the [redacted] increase seen in the most likely estimate comparing the 3-line to the 2-line system is directly offset by this corresponding [redacted] reduction for the pessimistic scenario incremental impacts, leaving the overall pessimistic estimate for the 2-line process the same as for the 3-line process at [redacted].

3.3 2-Line Process with Offsite Disposal Alternative

Most schedule durations for the recommended design alternative, 2-line with offsite disposal, are the same or very similar to the 2-line base case values. For construction, the most likely estimate is reduced slightly to [redacted]. This accounts for less equipment installed relative to the 2-line without offsite disposal case. No pessimistic estimates are provided for the 2-line cases.

The offsite waste disposal alternative should result in a decrease of the most-likely systemization period of [redacted] ([redacted] of formal systemization for a total duration of [redacted]): this is due to the loss of one DSH and two CSTs, a simplified DSH-to-CST transfer system, and a simplified CST OTS. [redacted] would also be deducted for the pessimistic estimate ([redacted] total duration).

For operations, the most likely schedule of [redacted] does not change because the DSH operations and reconfiguration (propellant removal) are not on the critical path. In addition, it is assumed that issues with processing propellant (e.g., threads from bags) in the ERHs are solved for the most likely case. For the pessimistic case, which includes risk from many areas, the effect of removing ERH propellant processing from the operations may reduce the schedule slightly, but it is estimated to be less than [redacted]; thus, the schedule estimate remains at [redacted].

For closure, the offsite disposal alternative is not expected to have a significant overall impact on closure duration. This is because two factors impact closure duration and they counteract each other. First, due to the elimination of the wood DSH and two CSTs/CST OTSs, there are fewer pieces of equipment that require removal and decontamination. While these pieces of equipment are not expected to be exposed to liquid agent contamination during their time in service, and chemical decontamination methods (if necessary) are likely be successful, their removal still represents a reduction in activities necessary for completion during closure. The second factor affecting closure duration is that the two removed CSTs also play a role in the treatment of TAP gear. Removal of the two units will increase the processing load for TAP gear on the remaining CST, which might extend the time necessary to process all of the contaminated TAP gear on site. This increased utilization for the CST is likely to offset any reductions in closure duration associated with there being fewer pieces of equipment to process. Consequently, the estimated closure duration for the 2-line process with offsite disposal remains at [redacted], the same as for the 2-line without offsite disposal. Similarly, the pessimistic estimated closure duration for the 2-line process with offsite disposal remains unchanged at [redacted].

4 Staffing

Mitretek conducted a top-down review of the staffing levels put forth in the IGCE proposed for the PCAPP 3-line process (PCAPP IGCE). Because the IGCE staffing estimate was based on—but considerably less than—the approximately [redacted] staff proposed by the systems contractor, Mitretek also considered, but did not include in this report, the staffing estimate proposed by the systems contractor. It should be noted that the staffing estimate provided by the systems contractor was based on an earlier PCAPP design and also contained some redundancies in staffing assignments. As a result, there was a significant reduction in the staffing levels, primarily in the Project Services classification, in the IGCE as compared to the system contractor.

The Mitretek analysis included a line-by-line assessment of each of the functional positions and the associated staffing levels proposed for the PCAPP facility as identified by BPT and in the IGCE. Mitretek also obtained and considered in its analysis the current and proposed staffing levels of the various baseline incineration facilities. Mitretek understands that, due to variations in both design and operations, there cannot be a direct, one-to-one correspondence between the incineration facilities and the proposed PCAPP facility.

In addition, Mitretek also analyzed and estimated potential staffing reductions that could be attributed to a PCAPP 2-line process, as suggested in §2 on page 13. The complete line-by-line analysis of the IGCE staff positions and applicable staffing levels for the various processing designs are provided in Appendix E on page 163. A summary of the overall analysis for both the 3-line and the 2-line processes, including the basis of the Mitretek staffing estimates, is discussed below.

The staffing estimates provided in this report are developed at a high level. In order to provide a more accurate assessment of staffing levels, a thorough analysis of PCAPP labor requirements should be undertaken.

4.1 3-Line "Base Case" Process

Similar to design features, there are also certain staffing requirements that are project-specific (needed regardless of design). Although these may change based on overall staffing, these positions are mandatory. These include the following:

- Business and Financial Services
- Contracting and Procurement Services
- Emergency Management Services
- Emergency Response Services
- Environmental Management Services
- Fire-Fighting Services
- Hazardous Material Response Team
- Medical Services
- Physical Security

- Plant Operations
- Security Services
- Surety
- Training Services
- Waste Management Services

The IGCE covered each of these areas. For some staffing positions (e.g., Medical Services), however, Mitretek observed redundancies and removed them from further consideration.

For the PCAPP 3-line process, the IGCE estimated an overall peak staffing level of [redacted] staff grouped into two general categories—Project Services and Plant Services. Project Services represents the administrative and oversight staffing assignments and consists of approximately [redacted] of the overall peak staffing estimate. Plant Services represents the functional positions associated with the day-to-day operation of the facility; examples of Plant Services assignments include plant operators, maintenance personnel, laboratory, and instrument technicians.

The staffing levels are ramped up through each phase of the PCAPP LCCE, beginning with construction and increasing until overall peak staffing levels are reached during systemization—specifically, at least [redacted] prior to the start of operations for Plant Services. Staffing then ramps back down at the conclusion of operations through the end of closure.

The IGCE and Mitretek peak staffing levels are shown in Table 4-1, below, and Table 4-2, on page 78, respectively. Although there is little difference between the overall peak staffing estimate of the IGCE and Mitretek's estimate, there are some noted differences when comparing staff levels as they ramp up or down during a given phase of the plant. For example, the ramp-up levels for Project Services staff calculated by Mitretek to support the systemization phase is lower than the levels estimated in the IGCE. The primary reason for this difference is that, although Mitretek used a linear ramp-up similar to the IGCE, the Mitretek ramp-up to overall peak staffing was over a longer duration than the IGCE.

Table 4-1 – IGCE Peak Staffing Levels by Phase for 3-Line Process (Headcounts)

Life Cycle Phase	Project Services(1)	Plant Services
Design	[redacted]	[redacted]
Construction	[redacted]	[redacted]
Systemization	[redacted]	[redacted]
Operations	[redacted]	[redacted]
Closure	[redacted]	[redacted]

(1) Source: (LCCE 2004) Appendix C2-[redacted]-PS 05-28-04 Rev 1.
(2) Source: (LCCE 2004) Appendix A1-[redacted]-FNM 05-28-04. Systems contractor staff during construction referred to as Field Non-Manual.
(3) Source: (LCCE 2004) Appendix E-Staffing Costs 05-28-04 Rev 2.

Table 4-2 – Mitretek Peak Staffing Levels by Phase for 3-Line Process (Headcounts)

Life Cycle Phase	Project Services	Plant Services
Design	[redacted]	[redacted]
Construction	[redacted]	[redacted]
Systemization	[redacted]	[redacted]
Operations	[redacted]	[redacted]
Closure	[redacted]	[redacted]

Figure 4-1 below summarizes the comparative staffing levels for the IGCE and the Mitretek estimates. As shown in the figure, the difference between the IGCE and Mitretek estimates is not considerable. The overall peak staffing estimate from the IGCE of [redacted] peak staff has been reduced to [redacted]. This reduction of [redacted] is primarily attributed to redundancies found in the IGCE staffing spreadsheets.

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Figure 4-1 – IGCE and Mitretek Peak Staffing Levels for 3-Line PCAPP

4.2 2-Line Process Alternative

As described in §2 on page 13, Mitretek suggests an alternative PCAPP design based on two processing lines rather than three. The Mitretek 2-line process is derived from the Mitretek 3-line process and involves removing various pieces of processing equipment, which affects the overall PCAPP staffing levels. As shown in Table 4-3 on page 79, the staffing estimate by phase for the Mitretek 2-line process offers the opportunity for a considerable reduction in the staffing requirements by phase when compared with the Mitretek 3-line process.

Table 4-3 – Mitretek Peak Staffing Levels by Phase for 2-Line Process (Headcounts)

Life Cycle Phase	Project Services	Plant Services
Design	[redacted]	[redacted]
Construction	[redacted]	[redacted]
Systemization	[redacted]	[redacted]
Operations	[redacted]	[redacted]
Closure	[redacted]	[redacted]

The reduction in administrative support (part of Project Services) such as desktop support, training specialists, and warehouse staff is generally attributed to a less complex and more manageable facility, as well as reduced activities because of a lower plant throughput for a 2-line process. The more notable reduction in staffing is within the category of Plant Services. This reduction is primarily attributable to the following:

- Fewer outside area operators, decreased from [redacted] to [redacted]
- Fewer control room operators, from [redacted] per shift
- Fewer electricians, from [redacted] per shift
- Fewer instrument technicians, from [redacted] per shift
- Fewer mechanics, from [redacted] per shift
- Fewer work control workers, from [redacted] per shift

The basis for this staff reduction is the assumption that the 2-line facility has a reduced overall plant throughput with the specified equipment removed. This lower throughput translates into less staff needed for tasks such as unpacking and so forth. Although a detailed job task analysis was not performed for this study, our experience suggests that a [redacted] reduction in manpower for unpacking and other outside operations is reasonable (i.e., from [redacted] outside area operators). Reductions in other functional positions are attributed in general to the lesser amount of equipment that would need to be monitored and maintained.

Figure 4-2 on page 80 summarizes Mitretek's estimates for a 3-line and 2-line PCAPP facility. The 2-line process has [redacted] fewer staff than the 3-line process—about an [redacted] reduction. Most of this reduction ([redacted]) occurs in the category of Plant Services.

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Figure 4-2 – Mitretek Peak Staffing Levels for 3-Line and 2-Line PCAPP

4.3 Mitretek Recommended Process

Potential reductions in staffing between the 2-line process alternative and the Mitretek recommended process, as described in §2.4 on page 43 (2-line process with offsite disposal of dunnage and propellant) was also assessed. Although there might be some reclassification of job positions, for example from waste treatment to waste shipment, there are no major reductions in staffing levels for a 2-line PCAPP with the offsite disposal alternative. In fact, detailed studies may indicate that additional staff is likely to be required for overseeing processing of the dunnage and propellant at the TSDF.[1]

The Mitretek analysis for staffing a 2-line facility with offsite dunnage and propellant disposal does offer the potential for an additional reduction of [redacted] staffing positions. All of these positions are within Plant Services and would only be realized if both disposal alternatives are invoked (see §5.4.3 on page 94). Table 4-4 on page 81 displays the staffing levels by phase for a 2-line process with offsite disposal.

[1] While the staff levels are not adjusted for these oversight activities, the cost analysis in §5 on page 82 includes [redacted] staff on temporary duty during operations for observing TSDF processing of dunnage and propellant.

Table 4-4 – Mitretek Peak Staffing Levels for 2-Line Process by Phase with Offsite Disposal (Headcounts)

Life Cycle Phase	Project Services	Plant Services
Design	[redacted]	[redacted]
Construction	[redacted]	[redacted]
Systemization	[redacted]	[redacted]
Operations	[redacted]	[redacted]
Closure	[redacted]	[redacted]

4.4 Staffing Analysis Summary

The estimated overall peak staffing level for the 3-line "base case" process is consistent with the overall peak staffing estimate from the IGCE. The less than [redacted] reduction in the 3-line "base case" estimate was attributable primarily to redundancies found in the IGCE staffing spreadsheets. There are differences however, in the peak staffing levels by phase within Project Services. This is because Mitretek used the same ramp-up methodology provided in the IGCE but over longer phase durations as identified in the Mitretek technical analysis.

The staffing analysis for the proposed Mitretek recommended process resulted in a considerable reduction in the overall peak staffing from the 3-line "base case" process. The primary reduction in staff was in Plant Services and can be traced to a large reduction in the number of outside area operators estimated to be needed to operate the 2-line facility. The reduction in staff is primarily attributed to the reduction in process throughput, which has an effect on such things as the number of munition movements and unpacking operations. Inclusion of the offsite disposal alternatives as described in the technical analysis for the Mitretek recommended process offers the potential for additional—albeit small—staff reductions.

In general, the staffing levels estimated to operate the PCAPP facility are substantial. Staffing the various phases of the PCAPP facility and subsequent ramping up to overall peak staffing levels will require access to a large and diverse labor pool for a significant period of time. While the planned ramp-up of staff will help, there are also many factors that can affect the availability of workers. Local workforce population and the skill base of those workers may not meet the staffing requirements of a facility the size and complexity of the PCAPP facility. In addition, concurrent construction projects in the local area may serve to diminish the amount of available workers. For example, a power plant that is being built in the area will have a significant impact on the availability of skilled workers for the planned PCAPP facility. To offset the potential labor shortage, BPT has in place a National Labor Agreement that should help to reduce the risk of worker shortages. However, as construction and operation of previous demilitarization facilities has shown, it has always been a challenge to fully staff the projects as planned.

5 Cost

The PCAPP LCCE increased considerably between the 2001 and 2004 estimates.[1] Mitretek attributes this primarily to the fact that the 2001 estimate was based on a conceptual design. The design has evolved since and is influenced by a desire to meet the CWC schedule, as well as incorporate lessons learned from other CDFs. It is also Mitretek's assessment that the PCAPP Neut-Bio design has been greatly improved—better performance with less technical and programmatic risk—over the original "fast path" conceptual design.

The objective of this cost analysis is to evaluate the current PCAPP LCCE (i.e., the intermediate design for a 3-line process) and quantify potential cost reductions from design changes that could decrease facility size, equipment needs, and staffing requirements. As part of this evaluation, Mitretek also considered disposal alternatives for the offsite processing of dunnage and propellant.

5.1 Approach

Mitretek analyzed the current PCAPP design to identify potential design changes that would reduce capital and other LCCs. Specifically, Mitretek's approach encompasses the following:

- Identify major cost drivers and evaluate the existing PCAPP LCCE (PCAPP IGCE)
    - Determine cost impacts from Mitretek's most likely and pessimistic schedule durations for systemization, operations, and closure phases of the current PCAPP design
    - Evaluate proposed staffing levels for the current PCAPP design, and adjust the LCCE for the current design, as appropriate (e.g., redundancies)
- Develop rough-order-of-magnitude (ROM) cost estimates for process features that could be modified or deleted to reduce LCCs without considerable impact on the overall destruction schedule, while maintaining compliance with safety and environmental requirements
    - Evaluate facility and equipment requirements for the modified design configuration—a 2-line process—and calculate cost reductions
    - Evaluate schedule durations and staffing requirements for the 2-line process and calculate associated cost impacts
    - Correspondingly, determine potential cost reductions with the offsite processing of dunnage and propellant.

The simplistic result of an LCCE study of the alternative is a parametric equation of alternatives versus LCCE, with the goal of finding the asymptote for the lowest LCCE while still maintaining a feasible process (e.g., a whole number of processing lines, publicly acceptable).

[1] Mitretek did not conduct a detailed cost evolution assessment, primarily because it was outside the scope of this task. Additionally, it should be noted that although such an assessment would detail a programmatic lesson learned, there is little apparent value to the path forward.

5.2 Cost Drivers

This section discusses the major cost drivers for PCAPP by life-cycle phase. Identification of these drivers allowed Mitretek to focus its analysis in areas that would achieve the greatest economic payoff in terms of opportunities for plant cost reductions.

Table 5-1 below and Figure 5-1 on page 84 display the PCAPP IGCE (IGCE 2004) for a 3-line PCAPP. In the table, costs are expressed in then year (TY) and constant 2004 (CN04) dollars. These estimates and the detailed work supporting them provided the starting point for Mitretek's cost analysis. It should be noted that Project Services (PS) and Program Management (PM) (a partial estimate) costs are expenditures incurred throughout the life cycle of the plant, but were not allocated by life cycle phase in the IGCE. To obtain the distributions shown in Table 5-1 and Figure 5-1, Mitretek allocated these costs among the five phases—design, construction, systemization, operations, and closure—according to the schedule duration of each phase. Phase overlaps for design/construction and construction/systemization were removed for this allocation: [redacted] of PS/PM to design; [redacted] to construction; [redacted] to systemization; [redacted] to operations; and [redacted] to closure.

As shown in the table, construction costs represent the largest share [redacted] of PCAPP LCCs. Almost [redacted] of construction costs are due to plant and equipment, and about [redacted] are labor costs.

The next largest cost shares are attributable to operations and closure, which respectively make up [redacted] and [redacted] of total LCCs. Systemization and design are [redacted] and [redacted], respectively, of the total. Slightly more than [redacted] of systemization costs and operations costs are due to labor.

Table 5-1 – IGCE Life Cycle Cost Estimates for PCAPP (1)

Life Cycle Phase	TY$ ($ 000s)(2)	CN04$ ($ 000s)(2)	% of Total(3)
Design	[redacted]	[redacted]	[redacted]
Construction			
Systemization			
Operations			
Closure			
TOTAL(4)			

(1) Source: FOCIS Associates, Inc., PCAPP LCCE 05-28-04 Rev 1 XFR1.
(2) Program Management costs are only partial estimates; therefore, the total LCCE is partial.
(3) Calculations based on constant (CN) dollar estimates.
(4) Totals may not add due to rounding.

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Figure 5-1 – Distribution of PCAPP IGCE Schedule Durations and Life Cycle Costs (Including Project Services and Program Management) by Phase

Based on these findings, Mitretek chose to investigate the areas of capital costs (plant and equipment) and labor. These topics are fully explored in §2 on page 13 and §4 on page 76, respectively.

5.3 Historical Perspectives

A recent report by the General Accountability Office (GAO 2003) noted that the Department of Defense's total cost for the destruction of chemical weapons rose from $15 billion in 1998 to $24 billion in 2001. Delays encountered since the program cost estimates were revised in 2001 have led to an estimated cost increase of $1.4 billion in October 2003. Based on events occurring since 2001, which have caused delays at the incineration sites (e.g., incidents during operations, environmental permitting, emergency preparedness, and budget shortfalls); the GAO expects this cost increase to rise further.

This section examines the historical cost and schedule of chemical agent disposal facilities employing the baseline incineration technology. The focus is on construction and operations costs, as these components appear to have considerable influence on the PCAPP design. Furthermore, the GAO report indicated that "schedule extensions are caused largely by actual destruction rates being lower than planned." Hence, plant operations must be effectively managed. The PM ACWA's approach to let one systems contractor design, build, operate, and close the PCAPP facility was intended to minimize the risk of schedule delays.

5.3.1 Construction Costs

A key concern regarding the current PCAPP design is that plant construction costs are considerably more than the baseline incineration facilities. Table 5-2 on page 85 shows the construction costs for five baseline incineration facilities. Mitretek recognizes the difficulty in comparing these estimates, particularly as funding streams (e.g., Military Construction; Research, Development, Test and Evaluation; and Procurement) and composition of cost elements (e.g., depot responsibilities) changed over time and across facilities.

Table 5-2 – Construction Costs for Baseline Incineration Facilities

Facility	Construction Cost (CN04$ millions)[(1)]
JACADS	[redacted]
TOCDF	
ANCDF[(2)]	
UMCDF	
PBCDF	

[(1)] (Mitretek 2002) Except for ANCDF, construction costs (2001 CN$) in the Mitretek report were converted to 2004 CN$.
[(2)] Source: (CMA 2004)

Each of these facilities experienced construction cost growths. For example, in 1988, TOCDF construction costs were estimated to be about [redacted] in CN04$, but actual construction costs were about [redacted] (CN04$)—almost a [redacted] increase. Lessons learned at TOCDF helped control construction cost growths at other facilities. For example, in 1996, the estimated construction costs for ANCDF were about [redacted] (CN04$), but the actual construction costs were [redacted] —about a [redacted] increase.

As discussed earlier, the PCAPP design incorporates three PMDs, munition reconfiguration, and additional process equipment the BPT designers deemed necessary to minimize the risk of schedule overruns for completing agent destruction in accordance with CWC treaty deadline (no later than 30 April 2012). Based on a [redacted] schedule, construction cost for the 3-line process is about [redacted][1] (excluding Project Services and Program Management costs of [redacted])—about [redacted] higher than the most expensive incineration facility, which is currently UMCDF. The approach taken for PCAPP is to build three processing lines with excess capacity and backups/redundancies to reduce the operating schedule duration and increase the potential for meeting the CWC treaty deadline. Thus, what appears to be a considerable upfront cost is anticipated to help reduce backend (operating) costs.

5.3.2 Operations Costs

For baseline incineration facilities, the major cost drivers have been operations costs. For example, a government estimate in August 2000 shows a [redacted] period for the operations phase at TOCDF (beginning on 1 August 1996 and ending by July 2005). In 2004, a revised government estimate for TOCDF operation duration ranges from [redacted] (CMA 2004). From data provided in a previous Mitretek report (Mitretek 2002), a [redacted] burn rate ($2004) for TOCDF operations can be calculated. At this rate, additional costs to the government due to schedule delays would be within the range of [redacted].

[1] Note that Mitretek did not assess PCAPP construction costs, but rather deferred that to the USACE.

5.3.3 Staffing

Table 5-3 below shows the actual staffing levels of the systems contractors at five stockpile disposal sites. Although not complete, the data provides some perspective on staff ramp-up from the systemization to the operations phase. It is worth noting the increase in staffing for TOCDF from the fourth quarter of 2002 to the present. This increase in staffing level (about [redacted] staff) was to alleviate the necessity to train personnel during off-shift periods, which required paying considerable overtime. Additional staffing was necessary to ensure personnel received the required training during their normal shift, while having enough staff to operate the facility.

Table 5-3 – Staffing Estimates at Stockpile Disposal Facilities

	CY 2000				CY 2001				CY 2002				CY 2003				CY 2004			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
ANCDF	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
UMCDF	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PBCDF	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
TOCDF	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
ABCDF	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

	Systemization
	Operations
###	*Actual Headcounts (average for quarter; data available until July 2004)*
###	*(Underlined) For July 2004 only*

* - *From the Government plan (CMA 2003b)*

As discussed in §4 on page 76, the IGCE peak staffing level during operations for PCAPP is [redacted] (PCAPP IGCE). This figure is still higher than those for baseline incineration facilities, but it is attributed to more systems to operate and maintain at PCAPP.

5.4 Life Cycle Cost Estimates

In this section, Mitretek evaluates the costs for three PCAPP processing alternatives, as discussed in §2 on page 13:

1. 3-line process (base case)
2. 2-line process
3. 2-line process with offsite disposal of dunnage and propellant

The third alternative is Mitretek's recommended process for PCAPP. For each alternative analyzed, Mitretek used the basic cost framework developed for the IGCE and assumed that plant construction begins in January 2005. Because Mitretek focused its analysis on construction cost drivers and labor during systemization, operations, and closure, no changes were made to the IGCE design costs. However, Mitretek recognizes that there will be costs incurred to redesign the PCAPP as a 2-line processing facility.

The construction schedule of [redacted] for the 3-line process—as indicated in the IGCE—is used in the Mitretek study. Mitretek did not evaluate the construction schedule estimate of the 3-line process or the assumptions behind the development of the schedule, but deferred to the judgment and expertise of the USACE, who are actively involved in the review and oversight of construction-related activities for PCAPP. Mitretek did, however, analyze and estimate the construction schedule for the 2-line process.

The annual distribution of Military Construction (MILCON) funds for construction costs, developed by the USACE Engineering Support Center, Huntsville (USACE-HNC), is used as-is; Mitretek did not verify the assumptions and calculations. The same is true for the Research, Development, Testing, and Evaluation (RDT&E) funds. Estimated construction cost changes focus primarily on direct costs associated with both MILCON and RDT&E funds.

It should be noted that the IGCE had only partial Program Management costs. This leads to an incomplete LCCE that propagated throughout the analysis of alternatives undertaken by Mitretek.

Other than labor, Mitretek did *not* adjust other recurring costs (e.g., other direct costs) as presented in the IGCE. This limitation was due mostly to time constraints in carrying out the design and cost analyses. Understandably, when detailed bottom-up cost estimates are prepared, all recurring—as well as non-recurring—costs will need to be revisited in light of any redesign efforts. It should be noted, however, that for phases whose schedule durations exceeded that of the IGCE, Mitretek roughly approximated those other recurring costs by extending their last annual value forward for the additional protracted period. For phases ending in a partial Fiscal Year (FY), the annual value of the recurring cost was adjusted by the increment of that FY.

Finally, while Mitretek noted various discrepancies related to systems contractor costs (e.g., annual work hours and overtime rates), the IGCE methodology was not adjusted. Again, this limitation was due to time constraints. Mitretek strongly recommends that such discrepancies be reconciled.

Each of the three alternatives under study is described below.

5.4.1 3-Line "Base Case" Process

From its review of the IGCE, Mitretek produced the following assessment:

- Schedule durations for systemization and operations are underestimated
- A [redacted] overlap of systemization with construction is optimistic
- Staffing levels need to be slightly adjusted for Project Services and Plant Staff

Mitretek believes that some schedule durations presented in the IGCE for the 3-line PCAPP are too short. Table 5-4 below summarizes those durations, as well as those estimated by Mitretek. Section 3 on page 48 provides the underlying rationale for the Mitretek estimates.

Table 5-4 – Schedule Durations for the 3-Line Process (Months)

Phase	IGCE	Mitretek	
		Most Likely	**Pessimistic**
Construction	[redacted]	[redacted]	
Systemization	[redacted]	[redacted]	[redacted]
Operations	[redacted]	[redacted]	[redacted]
Closure	[redacted]	[redacted]	[redacted]
(1) – [redacted] overlap with construction *(2) – [redacted] overlap with construction*			

The Mitretek staffing analysis found that the peak staff level for Project Services should decrease from the IGCE level of [redacted]. This reduction is primarily due to positions that are redundant, particularly with some of the Field Non-Manual staffing by the systems contractor during the construction phase (e.g., resident engineer). In addition, Mitretek's analysis shows that Plant Services staff should increase slightly—from [redacted]. For the most part, Mitretek concurred with the staffing mix presented in the IGCE. (For additional information, see Appendix E on page 163, which shows the staffing comparison between the IGCE and Mitretek, as well as identifies redundancies.)

Based on these adjustments in schedule and staffing, Mitretek re-estimated the PCAPP LCCs using the IGCE cost framework. Table 5-5 on page 89 gives the results from this analysis for the most likely schedule durations; Appendix F on page 173 refers to the detailed input spreadsheets with the corresponding calculations. In general, Mitretek followed the labor distributions in the IGCE to ramp staff up and down. For systemization, however, a steeper ramp-up of Plant Services staff was assumed because of the shorter overlap with construction and the desire to allow more time for training such a large staff. Peak staff levels are reached about [redacted] prior to the end of systemization; peak levels are maintained during the entire operations phase.

Table 5-5 – Mitretek Base Case LCCE for 3-Line PCAPP [1]

Life Cycle Phase	TY$ ($ 000s)[2]	CN04$ ($ 000s)[2]	% of Total[3]
Design	[redacted]	[redacted]	[redacted]
Construction			
Systemization			
Operations			
Closure			
TOTAL[4]			

(1) Framework based on IGCE—PCAPP LCCE 05-28-04 Rev 1.
(2) Program Management costs are only partial estimates; therefore, the total LCCE is partial. Project Services and Program Management costs are weighted by phase duration and distributed across the five phases.
(3) Calculations based on constant (CN) dollar estimates.
(4) Totals may not add due to rounding.

As shown by the results in Table 5-5 above, construction costs are still the dominant contributor to PCAPP LCCs—even with the longer duration ([redacted]) expected for operations. When compared with the IGCE (Table 5-6), Mitretek's base case LCCE is about [redacted] higher than the IGCE on a constant dollar basis. Note that the design and construction costs remain unchanged from the IGCE, as Mitretek did not adjust schedule or staffing for those phases.[1] For the most part, Mitretek's higher LCCE is due to longer schedule durations.

Table 5-6 – Comparison of LCCEs for 3-Line Process (CN04$ 000s)

Life Cycle Phase	IGCE	Mitretek	+/-%[1]
Design	[redacted]	[redacted]	[redacted]
Construction			
Systemization			
Operations			
Closure			
TOTAL			

(1) Mitretek did not adjust design or construction costs; the differences are anomalies from distributing Project Services and Program Management costs across the five phases.

1 For any redundant staffing between Project Services and Field Non-Manual, Mitretek adjusted the Project Services staffing, not the Field Non-Manual staffing. As a result of this, as well as no change in the construction schedule, there are no changes to construction costs.

The cost analysis is based primarily on most likely estimates for schedule durations, which are considered to be realistic estimates based on engineering judgment and historical experience. However, if any of the pessimistic durations in Table 5-4 on page 88 are realized, PCAPP LCCs would increase accordingly. A rough indication of those increases to the 3-line PCAPP is provided in Table 5-7 below. Based on these impacts, the worst-case (highest-cost increase) would involve the [redacted] closure duration, which adds about [redacted] dollars to total LCCs. In effect, this yields about an [redacted] increase from the IGCE LCCE of [redacted] to the adjusted Mitretek base case LCCE of [redacted].

Table 5-7 – Cost Impacts on 3-Line PCAPP Due to Pessimistic Schedule Durations

Life Cycle Phase	Monthly Burn Rate in CN04$ ($000s) (1)	Additional Months(2)	Additional LCCs in CN04$ ($000s)
Systemization	[redacted]	[redacted]	[redacted]
Operations	[redacted]	[redacted]	[redacted]
Closure	[redacted]	[redacted]	[redacted]

(1) Includes monthly costs of Project Services and (partial) Program Management.
(2) Derived from durations in Table 5-4 on page 88.

5.4.2 2-Line Process Alternative

In addition to different schedule durations and staffing requirements, the 2-line process for PCAPP has a smaller facility and less equipment than the 3-line process. Section 5.4.2.1 below discusses the schedule and staffing for the 2-line process, and §5.4.2.2 on page 91 gives details regarding the reductions in facility size and equipment needs.

5.4.2.1 Schedule, Staffing, and Demolition

Section 2, on page 13, and Section 3, on page 48, respectively, describe the 2-line PCAPP process alternative and provide schedule durations for each of its life cycle phases. Table 5-8 below summarizes those durations. Relative to the 3-line PCAPP, the 2-line facility is expected to have a slightly shorter construction period ([redacted] versus [redacted]), as well as a shorter systemization period ([redacted] versus [redacted]). Operations, however, will require [redacted] longer to complete than the 3-line facility.

Analysis of staffing levels and skill mixes for Project Services and Plant Staff showed a reduction in the overall peak staffing levels for the 2-line PCAPP from the levels Mitretek developed for the 3-line process. Mitretek expects that a 2-line process will require overall peak staffing levels of [redacted] for Project Services and [redacted] for Plant Staff. Appendix E on page 163 provides a line-by-line comparison of Mitretek's 3-line and 2-line staffing levels and shows the explicit changes in staffing for these labor categories.

Table 5-8 – Schedule Durations for the 2-Line Process (Months)

Phase	Mitretek	
	Most Likely	Pessimistic
Construction	[redacted]	
Systemization(1)	[redacted]	[redacted]
Operations	[redacted]	[redacted]
Closure	[redacted]	[redacted]

(1) – [redacted] overlap with construction

For the construction phase, Mitretek also reduced Field Non-Manual staffing to reflect the scaled down needs of a smaller-sized facility. Appendix E on page 163 identifies the explicit job titles for the 2-line construction peak staffing level of [redacted] for Field Non-Manual positions. Particular positions whose staffing levels were reduced from the 3-line level include cost management (Home Office [HO]), cost HO, designers/drafters, engineering design, engineers (civil/architectural/structural field), engineers (electrical/instrumentation field), engineers (mechanical/piping field), field engineer civil/structural, HO procurement, mechanical/piping superintendent, quality control (QC) inspector electrical, QC inspector mechanical/piping, and site documentation management.

Demolition costs of a smaller, 2-line facility should be less than the 3-line process plant. In this analysis, Mitretek assumed that demolition costs would decrease by [redacted].

5.4.2.2 Capital Cost Adjustments

Mitretek's analysis of the PCAPP design, as currently envisioned, indicates a potential for reduced capital costs. Such reductions would be the result of a smaller facility size to accommodate a 2-line processing plant. Appendix A on page 121 provides the details documenting the smaller facility size in terms of square footage reductions by contamination category. In estimating the capital cost reductions from the 3-line process, Mitretek assumed that the cost per square foot varied by construction type (see §A.2.1 on page 127). This variation in cost is due primarily to vapor and explosion containment.

Moreover, a 2-line PCAPP would have less equipment procured and installed than a 3-line processing facility. Table A-11 on page 134 in Appendix A identifies the equipment changes from a 3-line facility to a 2-line facility by process building type.

In accounting for both smaller facility size and less equipment, Mitretek estimates a construction cost reduction of [redacted] (CN04$) for the 2-line process alternative.[1] Of this estimate, about [redacted] (CN04$) is calculated as MILCON-funded; this cost reduction is taken from the cost category labeled “Directs—Site Work/Facilities/Buildings” in the IGCE. Distributions for taking this cost reduction were developed on the basis of the capital outlays presented in the IGCE.

The remaining cost reduction of [redacted] (CN04$) is RDT&E-funded. This reduction is taken from two IGCE categories: “Directs – Equipment/Subcontracts” and “Directs – Bulks + Installation Labor.” Similar to the approach used for reducing costs of MILCON-funded items, distributions for reducing the RDT&E capital costs were developed from the cost streams in the IGCE. About [redacted] was allocated to “Directs – Equipment/Subcontracts,” and the remaining [redacted] was allocated to “Directs – Bulks + Installation Labor.”

5.4.2.3 Life Cycle Costs for the 2-Line Process Alternative

Based on the adjustments in schedule, staffing, facility size, and equipment, Mitretek estimated the 2-line PCAPP LCCs by using the cost framework it developed for the 3-line base case described in §5.4.1 on page 87. Table 5-9 on page 93 contains the cost results using the *most likely* schedule durations given in Table 5-8 on page 90. Appendix F on page 173 provides a reference to the detailed input spreadsheets with the corresponding calculations.

Recall that in developing costs for each life cycle phase, other direct costs (ODCs) were not adjusted due to time constraints for the analysis. Because ODCs are related to both headcount and equipment requirements, ODCs will, in fact, be reduced for this alternative.

[1] Mitretek’s capital cost analysis is based on detailed construction costs for a 3-line PCAPP with a [redacted] construction period. Because the 2-line process is based on a [redacted] construction period, Mitretek had to prorate its cost reductions for consistency with the [redacted] period. Details regarding this adjustment are contained in spreadsheets referenced in Appendix F, §F.2, on page 173.

Table 5-9 – Mitretek LCCE for 2-Line PCAPP (1)

Life Cycle Phase	TY$ ($ 000s)(2)	CN04$ ($ 000s)(2)	% of Total(3)
Design	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]
Systemization	[redacted]	[redacted]	[redacted]
Operations	[redacted]	[redacted]	[redacted]
Closure	[redacted]	[redacted]	[redacted]
TOTAL(4)	[redacted]	[redacted]	[redacted]

(1) Framework based on Mitretek 3-line base case LCCE (see §5.4.1 on page 87).
(2) Program Management costs are only partial estimates; therefore, the total LCCE is partial. Project Services and Program Management costs are weighted by phase duration and distributed across the five phases.
(3) Calculations based on constant (CN) dollar estimates.
(4) Totals may not add due to rounding.

Construction costs of the 2-line process ([redacted] excluding Project Services and Program Management costs) decreased about [redacted] from the construction costs of the 3-line PCAPP ([redacted] excluding Project Services and Program Management costs). However, as shown in Table 5-9 above, construction continues to represent the largest share ([redacted]) of PCAPP LCCs. On a constant-dollar basis, overall LCCs for the 2-line PCAPP ([redacted] [B]) are about [redacted] less than the total LCCs for Mitretek's 3-line base case ([redacted] B). While this is not seemingly a large cost reduction, there are additional alternatives associated with the 2-line process that make this a desirable path forward for the destruction of mustard munitions at PCD. One such alternative—Mitretek's recommended processing alternative—is discussed below in §5.4.3 on page 94.

The cost analysis is based primarily on most-likely estimates for schedule durations, which are considered to be realistic estimates based on engineering judgment and historical experience. However, while some risk is already accounted for in the most-likely schedule estimates (see Table 5-8 on page 90), there is a possibility for those durations to increase. The impact on costs from such longer durations is provided in Table 5-10 on page 94. Based on these impacts, the worst-case (highest-cost increase) would involve the [redacted] operation duration, which would add about [redacted] dollars to total LCCs of the 2-line facility. In this case, the total LCCE would increase from [redacted] to [redacted] —about [redacted] increase. The additional LCC of [redacted] for the 2-line facility under pessimistic conditions is approximately [redacted] less than the corresponding [redacted] additional cost associated with the 3-line facility under pessimistic conditions.

Table 5-10 – Cost Impacts on 2-Line PCAPP Due to Pessimistic Schedule Durations

Life Cycle Phase	Monthly Burn Rate in CN04$ ($ 000s) (1)	Additional Months (2)	Additional LCCs in CN04$ ($ 000s)
Systemization	[redacted]	[redacted]	[redacted]
Operations	[redacted]	[redacted]	[redacted]
Closure	[redacted]	[redacted]	[redacted]

(1) Includes monthly costs of Project Services and (partial) Program Management.

(2) Derived from durations in Table 5-8 *on page 90.*

5.4.3 Mitretek Recommended Process

This processing alternative takes all factors into account as the 2-line process alternative described in §5.4.2 on page 90, but additionally considers the offsite processing of uncontaminated dunnage and uncontaminated, stable propellant. Table 5-11 below gives the schedule durations for this processing alternative. The only schedule differences between the 2-line process alternative and the Mitretek recommended process with offsite disposal are a slightly shorter construction duration ([redacted]) and slightly shorter systemization duration ([redacted]).

Table 5-11 – Schedule Durations for the 2-Line Process with Offsite Disposal (Months)

Phase	Mitretek	
	Most Likely	Pessimistic
Construction	[redacted]	
Systemization (1)	[redacted]	[redacted]
Operations	[redacted]	[redacted]
Closure	[redacted]	[redacted]

(1) [redacted] overlap with construction.

Similar to the 2-line process alternative, in developing costs for each life cycle phase, ODCs were not adjusted due to time constraints for the analysis. Because ODCs are related to both headcount and equipment requirements, ODCs will also be reduced for this alternative.

While overall peak staffing levels for Project Services is expected to remain unchanged from the basic 2-line PCAPP, the overall peak staffing level for Plant Staff is expected to be reduced from [redacted] to [redacted]. Mitretek's staffing analysis of the 2-line PCAPP with offsite disposal indicated a reduction of [redacted] outside area operators and [redacted] [redacted] from the basic 2-line levels. However, this reduction of [redacted] staff is offset by the need for an additional [redacted] monitoring instrument technicians. Hence, there is a net reduction of [redacted] staff.

Similar to the 2-line process alternative, demolition costs for the Mitretek recommended process is assumed to be about [redacted] less than the cost used in the LCCE for the 3-line "base case."

Mitretek made the identical capital cost adjustments to its recommended process alternative with offsite disposal of dunnage and propellant as the 2-line process alternative (see §5.4.2.2 on page 91). That is, a total of [redacted] (CN04$) was reduced from the 3-line cost estimate to reflect a smaller processing facility and fewer equipment needs. Of this estimate, [redacted] (CN04$) is MILCON-funded, and [redacted] (CN04$) is RDT&E-funded.

An additional adjustment to plant and equipment was also made because of the offsite processing of dunnage and propellant. Capital cost reductions related to these offsite activities are [redacted] (CN04$). Most of this reduction is for dunnage; the cost reduction for propellant is [redacted] ($CN04). Details regarding these adjustments are provided in Appendix A on page 121, as well as Appendix F (§F.3 on page 174).

A summary of other costs incurred with the offsite processing of dunnage and propellant is displayed in Table 5-12, below, and in Table 5-13, on page 96, respectively. The shipment and treatment costs for both dunnage and propellant were categorized as *Subcontracts & Outside Services* and assumed to be incurred during operations. A simplifying assumption was made to add these costs as a lump sum at the beginning of the operations phase. Mitretek recognizes that this assumption has implications for the LCCE when expressed in TY dollars and recommends that the cost allocation across time be more realistically determined upon any updates to this PCAPP LCCE.

Table 5-12 – Costs Associated with the Offsite Disposal of Dunnage

Item Description	Cost Basis	Change in LCC ($)
Dunnage		
(1) Develop and certify a procedure for demonstrating that wood dunnage is not agent contaminated	[redacted]	[redacted]
(2) Rental of roll-off containers	[redacted]	[redacted]
(3) Treatment of 1,574 tons of wood dunnage at a TSDF	[redacted]	[redacted]
(4) Shipping wood dunnage to TSDF at 7 tons/load	[redacted]; [redacted]; [redacted]	[redacted]
(5) Reduce quantity of ash shipped to TSDF by 62 tons	[redacted]	[redacted]
(6) Reduce quantity of carrier used in CSTs by 36.3 tons and 50% NaOH by 7.2 tons	[redacted]	[redacted]
(7) Reduction in power consumption with the deletion of one CST by approximately 20 million kWhr	[redacted]	[redacted]
(8) One staff at TSDF on temporary duty for duration of operations phase	[redacted]; [redacted]	[redacted]

Source: (FOCIS 2003)

Table 5-13 – Costs Associated with the Offsite Disposal of Propellant

Item Description	Cost Basis	Change in LCC
(1) Develop viable procedure to demonstrate that propellant is uncontaminated and certified for use at PCAPP	[redacted]	[redacted]
(2) Develop and certify a procedure to demonstrate propellant stability	[redacted]	[redacted]
(3) Packaging containers for 62 tons propellant (Category 1.1 DOT shipping container)	[redacted]	[redacted]
(4) Treatment of 62 tons of propellant at TSDF	[redacted]	[redacted]
(5) Shipping of 10 loads of propellant to TSDF	[redacted]	[redacted]
(6) One staff at TSDF on temporary duty for duration of operations phase	[redacted]	[redacted]

Source: (FOCIS 2003)

[redacted] staff will be needed to oversee the offsite processing of dunnage and propellant at the TSDF(s). These costs were categorized as labor expenditures during the operations phase and assumed to be incurred annually for the entire phase.

The remaining dunnage and disposal costs were classified as Subcontracts & Outside Services but were assumed to occur during the initial stages of closure. Again, a simplifying assumption was to make the adjustments (+ or –) as a lump sum figure. Similar to the shipment and treatment costs, this assumption has implications for the LCCE when expressed in TY dollars. Mitretek recommends that a more realistic expenditure flow be determined when PCAPP LCCEs are updated.

Based on the above inputs, LCCs were then developed for the Mitretek recommended process. Table 5-14 below presents the cost results for this process—a 2-line PCAPP that uses offsite processing for dunnage and propellant. Appendix F on page 173 provides a reference to the detailed input spreadsheets with the corresponding calculations for this alternative.

Table 5-14 – LCCE for Mitretek Recommended Process (1)

Life Cycle Phase	TY$ ($ 000s)(2)	CN04$ ($ 000s) (2)	% of Total(3)
Design	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]
Systemization	[redacted]	[redacted]	[redacted]
Operations	[redacted]	[redacted]	[redacted]
Closure	[redacted]	[redacted]	[redacted]
TOTAL(4)	[redacted]	[redacted]	[redacted]

(1) Framework based on Mitretek 2-line PCAPP LCCE (see §5.4.2 on page 90).
(2) Program Management costs are only partial estimates; therefore, the total LCCE is partial. Project Services and Program Management costs are weighted by phase duration and distributed across the five phases.
(3) Calculations based on constant (CN) dollar estimates.
(4) Totals may not add due to rounding.

Construction costs of the Mitretek recommended process ([redacted] excluding Project Services and Program Management costs) decreased about [redacted] from the construction costs of the 3-line PCAPP ([redacted] excluding Project Services and Program Management costs). However, as shown in Table 5-14 on page 96, construction still comprises the largest share ([redacted]) of PCAPP LCCs. On a constant dollar basis, overall LCCs for the 2-line PCAPP ([redacted]) are about [redacted] less than the total LCCs for Mitretek's 3-line "base case" ([redacted]).

The cost analysis is based primarily on most likely estimates for schedule durations, which are considered to be realistic estimates based on engineering judgment and historical experience. However, as discussed for the other two processing alternatives in this cost analysis, there is a possibility for the schedule durations of the recommended 2-line process to increase. The impact on costs from such longer durations is provided in Table 5-15 below. Based on these impacts, the worst-case (highest-cost increase) would involve the [redacted] operation duration, which would add about $[redacted] to total LCCs of the Mitretek recommended 2-line facility. In this situation, the total LCCE would increase from [redacted] to [redacted] —about a [redacted] increase. The additional LCC of [redacted] for the 2-line facility with offsite disposal under pessimistic conditions is approximately [redacted] less than the corresponding [redacted] additional cost associated with the 3-line facility under pessimistic conditions.

Table 5-15 – Cost Impacts on Mitretek Recommended Process Due to Pessimistic Schedule Durations

Life Cycle Phase	Monthly Burn Rate in CN04$ ($000s) (1)	Additional Months(2)	Additional LCCs in CN04$ ($000s)
Systemization	[redacted]	[redacted]	[redacted]
Operations	[redacted]	[redacted]	[redacted]
Closure	[redacted]	[redacted]	[redacted]

(1) Includes monthly costs of Project Services and (partial) Program Management.
(2) Derived from durations in Table 5-11 on page 94.

5.5 Cost Analysis Summary

Figure 5-2 on page 98 pictorially summarizes the LCCs in CN04$ dollars for the PCAPP alternatives analyzed. From an economic perspective, Mitretek supports the continued design and analysis of a 2-line PCAPP in conjunction with certain offsite disposal (e.g., dunnage and propellant). Unfortunately, the associated annual cost stream in Figure 5-3 on page 99 shows rather heavy outlays necessary during the early life cycle when capital investments must be made. The greatest outlay ([redacted]) would be needed in FY2007. Further design and analysis should be able to determine technical ways and economic strategies for reducing such cash flows.

Although the cost advantages for the Mitretek preferred alternative are not overwhelming, this alternative has intangible technical and programmatic merits that make it worth pursuing. In particular, the 2-line PCAPP with offsite disposal of dunnage and propellant is a much less complex plant than the 3-line plant. In this regard, programmatic risks may be easier to manage.

In the course of the analysis, Mitretek discovered numerous inconsistencies in the various cost estimates performed to date. Establishing PCAPP data quality is central to determining the confidence that can be placed in the technical and economic performance of this facility to process mustard munitions at the Pueblo Chemical Depot. At present, cost estimators are distributed among various organizations and their subcontractors (e.g., Corps of Engineers, systems contractor, Program Management Office, and program management support contractor). Data sources are disparate, and documentation tends to abound with discrepancies. Confidence in the estimated cost savings realized from the PCAPP design variants is only as good as the quality of data used to derive the cost estimates. A more rigorous quality control of cost data is needed. The initial steps towards enhancing data quality are close coordination among various parties involved in the cost analyses and documentation of data sources and assumptions.

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Figure 5-2 – Distribution of PCAPP LCCEs by Life Cycle Phase (CN04$)

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Figure 5-3 – Annual Costs of the Mitretek Recommended Process

6 Findings and Recommendations

As a result of the assessment, Mitretek has identified the following findings and recommendations.

6.1 Findings

Finding:	**Demilitarization Facility "Size"—For the most part, PCAPP's physical layout is appropriate for the given project objectives under which the systems contractor was operating. In addition, it is inappropriate to compare the size of PCAPP with a baseline incineration facility.**

Numerous government agencies have noted that the size of PCAPP's main demilitarization buildings is considerably larger than any baseline incineration facility; of particular concern was the size of the Contamination Category "A" and "B" areas.

It is true that PCAPP's main demilitarization floorspace is about 3.7 times larger than baseline incineration, with PCAPP's Category "A" and "B" area floorspace about 2.6 times larger than baseline incineration. However, these are apples-to-oranges comparisons. More appropriately, PCAPP should be compared to a combination of the baseline operations: reconfiguration, reverse assembly, neutralization, and thermal treatment. In addition, different processing schemes must be considered. For example, baseline typically stores many secondary wastes in the storage depot for later processing during closure or sends them offsite for disposal, whereas PCAPP was designed to process secondary wastes onsite as they are generated. It is Mitretek's assessment that the PCAPP design has appropriate space utilization; alternatives are identified that would decrease facility size, but these are strictly a result of changing the process.

It should also be noted that "size" is not the primary construction cost driver for PCAPP. For the current design, processing equipment (fabrication and installation) represents about twice the cost of the buildings that houses it for the EPB/APB, and that is assuming higher cost wall construction than proposed by the systems contractor. In other words, while making the facility "smaller" decreases construction costs, removing process equipment (with an associated decrease in facility size) provides the best savings.

The current PCAPP design was driven by the following:

- *Total Solution*—All wastes to be treated onsite
- *Baseline Lessons Learned*—Design facility to deal with munition anomalies and process problems observed during the baseline incineration and neutralization projects
- *Meet the Chemical Weapons Convention (CWC) Deadline*—Complete weapons destruction by 29 April 2012
- *Design Evolution*—Changes in the design that are part of the routine evolution of plant design from concept through implementation;
  ACWA's Accelerated Schedule Options that were incorporated to meet the CWC deadline (On 25 March 2002, the Under Secretary of Defense for Acquisition, Technology and Logistics directed the Army and PM ACWA to identify an approach to accelerate destruction of the chemical stockpile at Pueblo. Four Acceleration Options

were considered: Revised Acquisition Strategy/Contracting approach, construction before RCRA Part B permit, streamlined processing to include enhanced reconfiguration, and off-site shipment of process and secondary wastes.)

This is not to say that the project objectives cannot be changed. It is Mitretek's assessment that some or all of the objectives can and should be changed (see the design alternatives finding below).

Finding:	**Design Alternatives—All alternatives identified are technically feasible but some are likely to be politically infeasible. Some alternatives have tangible benefits, while others are somewhat intangible, but beneficial nevertheless.**

A number of PCAPP design alternative studies have been conducted by various government agencies. Mitretek independently conducted an evaluation of potential design alternatives in an effort to make PCAPP more economically feasible. The ground rules for Mitretek's consideration were that any change improve cost-effectiveness (without unreasonable affordability), that it be feasible, both technically and politically (e.g., public acceptance, environmental permitting, etc.), and that there are no unmanageable safety issues.

While costs and technical feasibility are tangible, political feasibility is intangible. Offsite disposal alternatives pose the greatest challenge. During community forums, the Pueblo community has voiced concerns about safety, loss of jobs, and sending Pueblo's wastes to other communities. Costs and benefits of off-site disposal alternatives were discussed with the Pueblo community in July 2003 as a result of an offsite disposal study (FOCIS 2003).

There are design alternatives that may make PCAPP more affordable and cost-effective. Offsite disposal of wastes typically improves both affordability and cost-effectiveness. Reduction in the processing capacity (e.g., fewer processing lines or postponing treatment) improves affordability but may worsen cost-effectiveness if it overly increases the life cycle schedule. The goal is to identify a process with less capacity that still has a net savings in the LCCE—that is, that cost increases resulting from an extended operations schedule are less than cost savings from construction and systemization schedule (closure can be a savings or loss depending on the alternative).

The operation of a 3-line facility has been examined and modeled to determine a base schedule and LCCE. The process alternative recommended by Mitretek is a 2-line process with offsite disposal of uncontaminated dunnage and uncontaminated and stable propellant. It is Mitretek's assessment that this process is more manageable and presents less programmatic risk (greater chance of success) than the 3-line process. It should be noted the minimizing that complexity of other portions of the facility may improve the manageability of the 3-line process. Some such alternatives, listed below, Mitretek recommends for further study:

- Offsite disposal of uncontaminated toxicological agent protective (TAP) gear (e.g., demilitarization protective ensemble [DPE])
- Offsite disposal of uncontaminated spent carbon
- Hot air decontamination of secondary wastes (e.g., DPE)

Other alternatives recommended for further consideration are listed below:

- Minimize the processing capacity for secondary wastes and buffer the excess onsite
- Process contaminated secondary waste in the MPT only, not the dunnage, shredding, and handling (DSH) line, keeping the DSH line uncontaminated
- Process surface-decontaminated ("3X" decontamination level) secondary wastes in the DSH only during a special campaign when leakers and rejects are processed in the Energetics Process Building (EPB)

Finding:	**Systemization Schedule—The systemization schedule is very optimistic, mostly due to the assumption that [redacted] of pre-systemization can be completed in parallel with construction, with only [redacted] of formal systemization.**

The IGCE systemization estimate includes [redacted] overlapping with construction (pre-systemization) followed by [redacted] of formal systemization. The baseline incineration average total systemization period, based on data from TOCDF, ANCDF, UMCDF, and PBCDF, is [redacted]. The PCAPP systems contractor's plan to modularly fabricate and test much of the PCAPP processing equipment offsite to reduce on-site systemization activities is innovative and aggressive, but it could prove very challenging. The initiation of on-site systemization after only [redacted] construction completion ([redacted] of construction) is deemed unrealistic due to predictable conflicts in the activities of both phases. A more realistic starting point for the initiation of systemization is at [redacted] construction completion ([redacted]). In addition, the large number of pieces of equipment, some of which have a high degree of complexity, offsets the gains resulting from offsite fabrication and testing. The Mitretek projection for the most-likely 3-line total systemization period is [redacted]—[redacted] of pre-systemization (overlapping with construction) followed by [redacted] of formal systemization. This projection is based on adjusting the average baseline systemization period by giving credit (a reduction in time) for fabrication and testing of equipment offsite and the need for only one integrated plant run for projectiles, as well as adding additional time for increased plant complexity over baseline. The Mitretek projection for the most likely 2-line systemization period is [redacted]—[redacted] of pre-systemization (overlapping with construction) followed by [redacted] of formal systemization.

Finding:	**Operations Schedule – The BPT operations schedule is optimistic, mostly due to the assumption of high availability for the PCAPP systems. The BPT and IGCE operations estimates do not include the schedule increase needed when leakers and rejects are processed at the end of operations.**

The operation of a 3-line facility has been studied and modeled to predict the operations schedule. Based on historical experience at Johnston Atoll Chemical Agent Disposal System (JACADS) and TOCDF, the normal processing rates specified by BPT are reasonable and have been demonstrated at these facilities on a sustained basis. However, BPT's estimated system availabilities were considerably higher than those typically demonstrated at JACADS and TOCDF. While Mitretek recognizes that certain systems may perform better than what has been demonstrated, it believes that BPT's availability estimates cannot be justified at this time. In general, BPT's predicted equipment availability estimates are reduced in the IGCE calculations and reduced further in the Mitretek calculations.

Mitretek's operation schedule also includes the significant effect of processing leakers/rejects on one line after all of the normal campaigns are completed. This change in the sequence of campaigns had not yet been taken into account in the BPT and IGCE estimates and is planned to address processing concerns from the Department of Defense Explosive Safety Board.

Mitretek's estimates for operations schedule durations are longer than the BPT or IGCE estimates. Durations are [redacted] for the 3-line base case (about [redacted] higher than the IGCE) and [redacted] for a 2-line case.

Finding:	**Concurrent Operations—Mitretek believes that concurrent processing of three munition types is feasible. However, there is potential for delays because of increased demand for repair/maintenance activities.**

Mitretek examined whether the facility designed for concurrent (simultaneous) processing of three types of projectiles/mortars would be feasible without adversely affecting throughputs. Proper planning, design, and staffing are needed to avoid degradation in throughput as was sometimes seen when TOCDF processed multiple munition types. PCAPP has been designed to process in this manner from the initial design with dedicated processing lines and enhanced support systems, such as additional control room workstations.

Mitretek believes that concurrent processing of three munition types is feasible and this scheme is utilized in all operations schedule estimates presented. However, the presence of the third line (regardless of what it is processing) would result in an increased demand for maintenance and repair activities. Because of potential conflicts and delays in personnel entries in DPE suits, a small delay time was added for times to repair systems in the EPB and APB in Mitretek's calculations of the 3-line operations schedule. This additional delay is assumed to not be needed for a 2-line facility and is not included in calculations of its operations duration.

Finding:	**Closure—The IGCE closure duration is appropriate and consistent with the closure duration estimate developed by Mitretek.**

The IGCE closure is based on a [redacted] duration. Mitretek performed its independent estimate of closure duration using the results achieved at JACADS for comparison. While the PCAPP process facilities are significantly larger than JACADS and with more equipment to decontaminate, these factors are compensated for by the increased use of chemical decontamination techniques to treat areas that had only been subject to agent vapor contamination, and by the redundancy in Metal Parts Treaters (MPTs) available to support thermal treatment activities during closure. After evaluating the individual increases or decreases in closure duration associated with each of the relevant factors as compared to JACADS, the Mitretek assessment also projects a duration of [redacted] for PCAPP closure of a 3-line facility. For the 2-line facility design, the utilization on only two MPTs would increase the closure duration slightly to [redacted].

Finding:	**Overall Schedule—The overall schedule to complete destruction of the munitions stored at Pueblo is considered to be optimistic by Mitretek; it has been adjusted to what Mitretek considers the "Most Likely" estimate.**

As noted earlier, Mitretek finds the IGCE for systemization and operations durations optimistic. Based on Mitretek's schedule adjustments, the complete destruction of the munitions stockpile at Pueblo occurs [redacted] beyond the CWC treaty deadline. Pessimistic values were also determined to establish estimated ranges for schedule durations.

Finding:	**Staffing—In general, the IGCE staffing levels and mix are reasonable for the proposed 3-line process. With the Mitretek recommended process (2-line with off-site disposal of uncontaminated dunnage and propellant), however, considerable staff reductions are possible.**

For the 3-Line process, the IGCE estimated an overall peak staffing level of [redacted] personnel, while the Mitretek overall peak staffing estimate was [redacted]. The less than [redacted] difference is primarily attributed to redundancies found in the IGCE staffing plan and small variations in staffing levels proposed by Mitretek.

The staffing estimate for the proposed Mitretek 2-Line process is approximately [redacted] lower than the staffing level proposed for the Mitretek 3-Line process. This reduction is primarily attributed to a significant reduction of Plant staff (outside area operators, maintenance personnel, instrument technicians, etc.).

Finding:	**Historical Costs—Based on the IGCE, PCAPP construction costs are about [redacted] higher than the most expensive baseline incineration facility (Umatilla). Additionally, the IGCE peak staffing level during operations has [redacted] more staff than the Tooele plant—the largest staffed baseline incineration facility.**

These observations are primarily based on the schedule-driven, "total solution" design philosophy of PCAPP, as well as the systems requirements for the selected destruction technologies. PCAPP is a 3-line facility designed with excess capacity and backup/redundancies to increase the potential for meeting the CWC treaty schedule. The relatively higher PCAPP staff level is attributable to the fact that PCAPP has more systems to operate and maintain than baseline incineration.

Finding:	**Cost—The Mitretek recommended process, a 2-line PCAPP with offsite disposal of dunnage and propellant, is expected to cost about [redacted] in constant 2004 dollars (CN04$). This represents about a [redacted] decrease in total life cycle costs from the 3-line "base case" process ([redacted]).**

Mitretek's cost analysis of PCAPP indicates decreases in overall life cycle costs if certain redesign efforts are carried out. After evaluating the IGCE and adjusting that estimate downward for slightly lower staff levels but upward for longer schedule durations, the Mitretek 3-line "base case" is expected to cost about [redacted] (CN04$). This is about [redacted] more than the IGCE estimate of [redacted] (CN04$). In contrast, Mitretek evaluated a smaller 2-line PCAPP that would send uncontaminated dunnage and uncontaminated, stable propellant offsite for processing. This facility is estimated to cost about [redacted] (CN04$).

Finding:	**Affordability—During its early life cycle, annual PCAPP spending may exceed [redacted]. With design variants, PCAPP can be made more affordable and cost-effective without sacrificing safety and environmental considerations.**

The planned yearly expenditures for PCAPP construction are higher than that achieved for any of the baseline incineration facilities. During Mitretek's discussions with government agencies, concern was raised regarding the yearly expenditures and ability to budget—as well as spend—such large amounts. Although capital investment is still expected to remain high in the early years, Mitretek's analysis indicates that the 2-line process with the offsite disposal of dunnage and propellant begins to offer technical solutions for reducing costs.

Finding:	**Technology Certification—Increases in the LCCE of PCAPP from what was certified to Congress in 2003 are primarily due to development of the design for this emerging technology.**

The current PCAPP Neut-Bio technology has changed notably since the conceptual design that was certified to Congress in 2003. Most of this is attributed to the normal evolution of an emerging technology from concept design to current intermediate design. Detailed information regarding this finding is published in a separate Mitretek report.

6.2 Recommendations

Based on these major findings, Mitretek recommends the following actions or activities:

Recommendation:	**2-Line Process—The PM ACWA should focus any redesign efforts on the adoption of a 2-line process for PCAPP, with trade studies conducted to address issues regarding plant throughput enhancements.**

Based on Mitretek's evaluation, the 2-line process with offsite disposal of dunnage and propellant provides a cost savings of about [redacted] (CN04$) relative to a 3-line process. A more detailed engineering evaluation needs to be performed to identify any design issues related to this process configuration. A capital cost review would be needed to determine whether additional cost reductions are possible.

Recommendation:	**Cost Budget—The PM ACWA should review the statement of work for the PCAPP systems contractor to allow it to verify the effectiveness of the performance-based mechanism to track cost throughout the program, specifically addressing cost growths and ceiling**

The issue of cost growth and ceilings should be more explicitly addressed in the BPT contract. While the systems contractor has incentives to meet schedule and comply with CWC treaty requirements, currently, there appears to be no effective mechanism in place to track construction costs. BPT is subject to the Army's Earned Value Management System (EVMS), but tracking construction costs did not seem to keep pace with the design. Furthermore, performance-based requirements should be a function of the funding profile because affordability is clearly becoming an important issue that needs to be addressed and tracked accordingly.

Recommendation:	Public Outreach—The OSD and PM ACWA should actively work with the local communities and the state regulators to get their support for the offsite disposal of dunnage and propellant.

Although an environmental assessment has been performed indicating that offsite disposal of uncontaminated dunnage and of uncontaminated and stable propellant shows no significant impact (ANL 2004), it is important to actively engage the community and the regulators by discussing concerns that they may have regarding additional actions. The OSD and PM ACWA will have to discuss the costs associated with building and operating PCAPP in light of the overall DOD budget constraints; public cooperation and support will be needed to make offsite disposal a viable option.

Recommendation:	Validation and Verification of Life Cycle Costs—Due to the criticality of current budgetary issues, a rigorous, well documented, validated life cycle cost estimate (LCCE) that garners the involvement of all participating agencies is needed.

Establishing PCAPP data quality is central to determining the confidence that can be placed in the technical and economic performance of this facility to process mustard munitions at the Pueblo Chemical Depot. At present, cost estimators are distributed among various organizations and their subcontractors (e.g., Corps of Engineers, systems contractor, Program Management Office, and program management support contractor). Data sources are disparate, and documentation tends to abound with discrepancies.

Confidence in the estimated cost savings realized from the PCAPP design variants is only as good as the quality of data used to derive the cost estimates. A more rigorous quality control of cost data is needed. The initial steps towards enhancing data quality are close coordination among various parties involved in the cost analyses and documentation of data sources and assumptions.

Glossary

The following is a glossary of selected terms and acronyms, some with descriptions.

Symbols & Numerical

$...dollars (US)
3X..See XXX
5X..See XXXXX

A

ABCDF ....Aberdeen Chemical Demilitarization Facility
ACAMS ....Automatic Chemical Agent Monitoring System
ACWA ....Assembled Chemical Weapons Alternatives
ADM ....Acquisition Decision Memorandum. An ADM: Typically authorizes the program to proceed to the next acquisition phase, provides direction to the program manager, and establishes exit criteria, which are critical results or events that must be attained during the next acquisition phase and before the next milestone.
AEL.......................................Airborne Exposure Limit
agent......................................lethal chemical vesicants and nerve agents: VX, GB, HD, T, H or HT (ACWA) and GD, GB
ANCDF.................................Anniston Chemical Agent Disposal Facility
artillery shell ....a projectile fired by machinery moved equipment: chemical artillery shells consists of 105-mm M60 & M360; 155-mm M104, M110, M121, & M121A1; 8-inch M426 munitions

B

BFD.......................................block flow diagram
biotreatment ....destruction of organic material using *biomass*
BRA ....brine reduction area (baseline)
BRS.......................................burster removal station on PMD, extracts bursters from artillery shells
BSRS.....................................burster size reduction station at modified RSM/RSS, shears bursters
burster ....explosive bursting charge used to rupture munitions. Typically consists of a thin metal or plastic tube filled with explosive.
BWM.....................................burster washout machine

C

CAMDS ....Chemical Agent Munitions Destruction System (CAMDS) [now called the Oquirrh Mountain Facility (OMF) plant] at Deseret Chemical Depot
caustic ....a solution containing dissolved base, which is capable of undergoing chemical reactions (e.g., hydrolysis) that decompose agents and energetics.
cascaded ventilation system...HVAC control strategy ventilation air from less agent contaminated area to more contaminated

CDF..chemical demilitarization facility
CEMS.....................................Continuous Emissions Monitoring System (usually referring to stack monitoring)
CLIN......................................Contract Line Item Number
contamination category..........an alpha character assigned to an facility area (usually by room) designated the probably of agent contamination
CN..constant; as used in constant 2004 dollars (CN04$)
CSDP.....................................Chemical Stockpile Disposal Program (US Army, PMCD)
CSTR.....................................continuously-stirred tank-reactor
CW...chemical weapons
CWC......................................Chemical Weapons Convention
CWM.....................................chemical warfare materiel
CY..constant year

D

DAAMS.................................Depot Automated Agent Monitoring System
decon......................................decontamination solution (typically aqueous solutions of NaOH, HTH, or bleach)
degrees Celsius.......................a measure of temperature. (to convert to degrees Fahrenheit subtract 32 from the temperature in °F and divide the difference by 1.8).
DPE..Demilitarization Protective Ensemble (an OSHA Level A PPE, SCBA and airtight impervious suit, part of TAP gear)
dunnage..................................packaging material consisting mostly of wood, foam, and metal banding. Sometimes used when referring to *secondary wastes*

E

ECR..Explosion Containment Room
effluent...................................Any gas, liquid, or solid produced by the system at any point throughout the entire process that is, or potentially can be, emitted, discharged, or released to the environment.
energetics...............................highly reactive chemical compound or composition typically relating to explosive materials.
EPA..Environmental Protection Agency
ERH..Energetics Rotary Hydrolyzer, a steam heated rotary drum with caustic-filled flights used to dissolve/hydrolyze energetic material from its hardware
ETS..Energetics Transfer System
explosive................................An *energetic* substance, compound, or formula that rapidly produces gas and heat upon decomposition. For the *ACWA* Program:
Burster, supplemental, and initiating charges of *TNT*, *tetryl*, and *RDX explosive*s with inert constituents in various formulations (i.e., *Tetrytol*, *Comp B*, *Comp B4*, *Comp A5*)
Double-base *propellant* (*NG* and *NC*)
Fuze detonation and *pyrotechnic igniter* trains (mixtures of *lead azide, black powder, lead styphnate, barium nitrate, tetracene,*

potassium chlorate, antimony sulfide, carborundum, lead thiocyanate, and other inorganic high explosives

F

facility ....The structure or group of buildings used to perform any of the consecutive steps in the unloading, disassembly, neutralization, demilitarization, or salvaging of an assembled chemical weapon, it’s components, it’s chemical and explosive fills or their simulants.

FCS ....Facility Control System

FPS ....Facility Protection System

FY ....fiscal year

G

g..grams

GA or General Atomics ....ACWA offeror (cryofracture/hydrolysis/SCWO/thermal)

H

H..mustard vesicant, not distilled

HD...mustard vesicant, distilled, a blistering agent also referred to as *H, mustard, sulfur mustard,* and mustard gas. Technical name: 1,1'-thiobis[2-chloroethane].

HDC ....heated discharge conveyor (baseline electrically-heated, bucket conveyor furnace)

HE ....high explosive

HO...home office

HT ....mustard vesicant, a mixture of 60% *HD* and 40% *T* by weight.

HVAC ....heating, ventilation, and air conditioning system; with chemical agent, also may refer to the cascaded ventilation system

hydrolysate.............................product from hydrolysis neutralization of agent and energetics

hydrolysis...............................a chemical decomposition process of involving the splitting of a chemical bond through the addition of the hydrogen cation and the hydroxide anion of water.

hydropulping..........................process of pulping material in an aqueous media

I

IAW..in accordance with

ICB..immobilized cell bioreactor

IPR ....integrated plant run

J

JACADS ....Johnston Atoll Chemical Agent Disposal System

K

L

landfilled ....disposal of waste in a controlled, underground location

lb ....pound

leaker.....................................CWM indicating leakage of chemical agent

LEL ....lower explosive limit
LPS..Lightning Protection System

M

M104......................................155-mm artillery shell with H or HD fill, M6 burster charge, M1 burster casing, fuze well cup, and lifting plug
M110......................................155-mm artillery shell with H or HD fill, M6 burster charge, M1 burster casing, fuze well cup, and lifting plug/fuze adapter
M2..4.3-inch mortar with aluminum baffle, HD or HT fill, burster well, and burster charge screwed to M8 fuze
M2A1.....................................4.3-inch mortar with steel baffle, HD or HT fill, burster well, and burster charge screwed to M8 fuze
M360......................................105-mm artillery shell with HD fill, M40 burster charge, M16 burster casing, and M508A1 fuze
M60..105-mm artillery shell with HD fill, M5 burster charge, M5 burster casing, and M57 fuze
MDC ....materials decontamination chamber (an electrically-heated "oven" at CAMDS)
metal parts..............................the munitions hardware consisting of metal (e.g., projectile shells, rocket motor bodies, rocket warhead bodies, burster wells, fuze wells, fuze adapters).
micro ....10^{-6} (1 PPM)
MINICAMS ....Miniature Chemical Agent Monitoring System
Mitretek..................................Mitretek Systems, Incorporated
mortar.....................................a projectile fired by manually-transportable equipment: consists of the 4.2-inch M2/M2A1 munition
MPC ....miscellaneous parts conveyor (baseline: transports parts from the PMD NCRS and MPRS)
MPF..metal parts furnace (baseline duel-fuel, direct-fired combustion conveyor furnace)
MPL ....multi-position loader (loads projectiles form a conveyor to a tray)
MPRS.....................................miscellaneous parts removal station on PMD, removes fuze well cups and supplemental charges
MPT ....metal parts treater
MSDS.....................................material safety data sheet
munitions................................the components and process related materials present in a fully assembled chemical weapon, and part of the Assembled Chemical Weapons Stockpile.

N

n...nano (10^{-9})
N_2 ....nitrogen
NaOH ....sodium hydroxide, a strong base/caustic
NCRS ....nose-closure removal station on PMD, removes fuzes (while accessing booster) or lifting plugs from artillery shells, removes fuzes and bursters (while accessing) from M2/M2A1 mortars.
NECDF ....Newport Chemical Agent Disposal Facility

neutralization.........................as it is commonly referred to chemical demilitarization, neutralization is the process of hydrolysis used to detoxify (or make less hazardous) and to de-energize the chemical agent and energetic materials.
NRC ....National Research Counsel

O

OMF.......................................Oquirrh Mountain Facility (OMF) plant, formally known as the Chemical Agent Munitions Destruction System (CAMDS) at Deseret Chemical Depot
OSHA....................................Occupation Safety and Health Association
overpack................................manually installed vapor containment device for CWM indicating leakage (AKA "pig")
oxidation ....a combination of oxygen with a substance to produce a chemical change in which an atom loses one or more electrons; an oxidation always accompanied by a reduction (see definition of "Reduction").

P

Pa...Pascal (98,100 Pa = 1 N/m^2 = 1 atm = 14.7 PSI)
PAS ....pollution abatement system
PBCDF..................................Pine Bluff Chemical Agent Disposal Facility
PBW......................................parts or percent by weight
PM ACWA............................Program Manager for Assembled Chemical Weapons Alternatives
PMCD ....Program Manager for Chemical Demilitarization (US Army, SBCCOM), now CMA
PMD......................................projectile and mortar disassembly machine: consists of NCRS, MPRS, BRS
POTW ....Publicly Owned Treatment Works
PPB ....parts per billion (1 in 1,000,000,000)
PPE..personal protective equipment (DPE, shoes, gloves, hats, masks, clothing, etc.)
PPL..pick and place loader (baseline: moves projectiles from tray to MDM and back)
PPM.......................................parts per million
PPMV....................................parts per million by volume
projectile ....artillery shells and mortars
propellant ....formulation of energetic materials to provide gas propulsion (thrust)
PSI...pounds per square inch (should be presented as PSIA or PSIG)
PSIA......................................pounds per square inch, absolute
PSIG......................................pounds per square inch, gauge
pyrolysis................................thermal decomposition in the absence of oxygen

Q

QC...quality control

R

RCRA.....................................Resource Conservation and Recovery Act
reverse assembly ....The name given to the baseline process which disassembles munitions to access the agent and energetics for subsequent processing. The baseline reverse assembly for projectiles consists of removing the nose closures (to include fuzes), bursters, and agent. The baseline reverse assembly for mines consists of a punching operation that accesses the agent and energetics and for rockets it consists of punching, draining and shearing. The baseline reverse assembly can be used in proposed solutions as long as it is properly integrated.
RSM ....rocket shear machine for accessing M55 rockets: consists of RDS and RSS
RSS ....rocket shear station on RSM, shears M55 rockets into sections

S

SCBA ....self-contained breathing apparatus
Schedule 2..............................a section of the CWC listing toxic chemicals and their precursors (the components used to create the toxic chemical) as defined by the Chemical Weapons Convention.
SCWO....................................super-critical water oxidation. (A process used to oxidize organic compounds. The process makes use of some of the unique properties of water at temperatures and pressures above the critical point of water which is 705.2°F and 3,204.6 PSI. The organic wastes are entrained in a common water stream that is fed into the SCWO reactor, which oxidizes the organic wastes to carbon dioxide and water. The inorganics that are contained in the waste stream settle out as oxides and salts.
SDS ....spent decon solution (decontaminated spot decon solution, sampled and verified agent free)
secondary wastes....................including but not limited to dunnage, waste oils, spent hydraulic fluid, PPE, spent decon (SDS), spent activated carbon, and sundry metal parts
SETH......................................simulated equipment training hardware
simulant
slurry ....entrained solids or flocculants in liquid
SOP ....standard operating procedure
SOW.......................................statement or scope of work
subscale ....smaller than full-scale
supernatant ....the usually clear liquid overlying material deposited by settling, precipitation, or centrifugation

T

T ....a vesicant: 1,1'-oxybis[2-[(2-chloroethyl)thio]ethane]
TAP ....Toxicological Agent Protective
TDG ....*thiodiglycol* (major reaction product for mustard hydrolysis)
thiodiglycol ....*TDG* (major reaction product for mustard hydrolysis)

TNT..trinitrotoluene, an amorphous, castable (low MP), DOT Class 1.1 explosive
Tooele ....location of TOCDF and CAMDS
TOCDF ....Tooele Chemical Agent Disposal Facility
TOX ....toxic cubical (baseline agent holding system)
toxic..A chemical falling within any of the following categories:
A chemical that has a median lethal dose (LD(50)) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
A chemical that has a median lethal dose (LD(50)) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
A chemical that has a median lethal concentration (LC(50)) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.
TWA ....time-weighted average (a sampling protocol)
TY ....then year

U

UMCDF ....Umatilla Chemical Agent Disposal Facility
USACE ..................................U.S. Army Corps of Engineers

V

vesicant ....a blistering agent
VOC.......................................volatile organic compounds

W

X

XXX.......................................AKA 3X, an agent or energetic decontamination level [A designation defined in the Department of the Army Pamphlet 385-61 used to indicate that an item has been surface decontaminated (if required) by locally approved procedures, bagged or contained, and that appropriate tests or monitoring has verified that vapor concentrations above the lowest detectable limit for mustard agents, 0.0001 mg/m^3 for GB, and 0.00001 mg/m^3 for VX do not exist.]
XXXXX)................................AKA 5X, agent or energetic decontamination level to allow release from government. [Agent: a designation defined in the Department

of the Army Pamphlet 385-61 used to indicate that an item is clean and may be released from Government control without precautions or restrictions. An approved method of achieving 5X level is subjecting items for a sufficient time at sufficient temperature to completely destroy agent or energetics. For disassembled items, heating the item to 538°C (1,000°F) for 15 minutes is considered sufficient.

Y

yr ....year

Z

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Appendix A Alternatives Evaluation

A.1 Approach

A.1.1 Input Cost Data

For the most part, the assessment of technical and political feasibility of a potential alternative determined whether Mitretek would develop a corresponding LCCE for the alternative. Cost savings were tangible and significant in some cases, but without chance of programmatic success such estimates would be purely academic.

Mitretek used the IGCE (IGCE 2004) to evaluate the cost of the alternatives. Within the IGCE are bottoms-up, line-by-line cost estimates for PCAPP based on two funds: the Military Construction (MILCON) fund, labeled MCD, and the Research, Design, Testing, and Engineering (RDT&E) (labeled RDTE) fund. For the most part, the MCD costs include the building (e.g., concrete, structure, HVAC, lighting, etc.) and site infrastructure (e.g., utilities, security, etc.) costs while the RDT&E costs include process-related costs. Costs are contained in a complex Excel workbook (~2,475 MCD line items; ~5,730 RDT&E line items) developed by Project Time & Cost (PT&C) for the U.S. Army Corps of Engineers (USACE) using inputs from BPT and from FOCIS Associates. PT&C has developed similar cost analyses for the baseline CDFs.

The PT&C spreadsheets have a "source tag" similar to a work breakdown structure (WBS). Each line item was assigned a facility (see Table A-1 on page 122), system (see Table A-2 on page 123), and commodity (see Table A-3 on page 124). During Mitretek's assessment, errors were found and corrected. In mid-September 2004, a new version of the workbook was distributed by PT&C correcting errors due to mistaken allocation of line items by system. The total cost did not change; just the allocation of line items. It should be noted during reassessment, it was found that although many line items changed, the cost by system did not change dramatically.

The spreadsheets provide costs for construction: project cost (labor, equipment, and materials), escalation, allowances, and fees. Additional staffing—field non-manual staffing, project services staffing, and plant staffing—costs are added in the LCCE spreadsheets (see Appendix F on page 173).

A.1.2 Mitretek Approach/Data Manipulation

Mitretek centered its construction cost evaluation primarily on the most costly factors of the design—the process-related factors, such as the EPB, APB, and BTA. Much of the rest of the site is required regardless of facility size/capacity (the "price of doing business", such as the "ancillary" category) while some other areas would only show a marginal savings regardless of a change. Mitretek's approach was to categorize costs by facility and further consolidate costs by those showing a significant cost savings, using process related and ancillary as major discriminators.

Mitretek initially adjusted the line items for PT&C's RDT&E spreadsheet to achieve the cost savings of the candidate alternatives. As noted above, misallocation errors were corrected in the workbook, which consequently invalidated Mitretek's original approach. Further study of the data (and necessity) led Mitretek to a different approach. Even with the new workbook, questionable allocations were still identified. Mitretek reallocated costs where deemed appropriate (it should be noted that these, as a whole, do not represent significant cost). For example, a number of items allocated to facility designation 201.00, Site Preparation, belonged to 212.00, Utility Building. In addition, Mitretek's original approach was too labor-intensive to conduct every time costs changed or were reallocated. Finally, the PT&C spreadsheet provided a fine division of costs, more than was needed for the Mitretek assessment.

For the new approach, Mitretek consolidated the facility and system costs in the MCD and RDT&E spreadsheets by assigning categories also shown in Table A-1 through Table A-3. For example, combining like systems under "Utilities", "HVAC", and "Controls; combining BTA and Post Neutralization designations as "Post Neut", and combining many non-process related items as "Ancillary". The resulting cost consolidations of this approach are shown in Table A-4 on page 125 for MCD and Table A-5 on page 125 for RDT&E. These are provided in decreasing cost to indicate where facilities and systems reductions would provide the most savings. The RDT&E consolidation data was further used for factoring reduction estimates for the alternatives.

Table A-1 – Cost Data: Facility Identifiers

Facility	Description	Mitretek Facility Category
201.00	Site Preparation / Improvements	Site Prep
202.00	Utilities, Under Ground	Utilities
203.00	Utilities, Above Ground	Utilities
205.00	Energetics Processing Building (EPB)	EPB
206.00	Agent Processing Building (APB)	APB
207.00	Demilitarization Filter Area (DFA)	DFA
208.00	Control and Support Building (CSB)	CSB
209.00	Process Auxiliary Building (PAB)	PAB
210.00	Post Neutralization Building & Equipment	Post Neut
211.00	Integrated Process & Facilities Control System (ICS)	CSB
212.00	Utility Building (UB)	Ancillary
213.00	Laboratory/Lab Filter Area (Lab/LFA)	Lab
213.01	Laboratory (Lab)	Lab
213.02	Lab Filter Area (LFA)	Lab
221.00	Standby Diesel Generator (SDG)	Ancillary
222.00	Personnel Maintenance Facility (PMB)	Ancillary
223.00	Entry Control Facility (ECF)	Ancillary
223.01	Entry Control Facility #1 (ECF #1)	Ancillary
223.02	Entry Control Facility #2 (ECF #2)	Ancillary
224.00	Gas Mask Storage Building (GMS)	Ancillary
225.00	Warehousing Outside Fence (WOF)	Ancillary
226.00	Maintenance Building (MB)	Ancillary
227.00	Fuel Oil Storage (FOS)	Ancillary
228.00	Mechanical & Electrical Building (MEB)	Ancillary
229.01	Biotreatment Area (BTA)	Post Neut

Facility	Description	Mitretek Facility Category
229.02	Filter Electrical Building (FEB)	DFA
229.05	Waste Storage Building (WSB)	WSB
229.06	BTA Electrical Building (BEB)	Post Neut
229.99	Miscellaneous / Holding Account	Ancillary

Table A-2 – Cost Data: System Identifiers

System	Description	Mitretek RDT&E Category
A00	All / Unallocated System	All/Unallocated
B01	Projectile Handling System (PHS)	PHS
B02	Munition Washout System (MWS)	MWS
B03	Energetics Rotary Hydrolyzer/Heated Discharge Conveyor (ERH/HDC)	ERH/HDC
B04	Agent Collection System/Agent Neutralization System (ACS/ANS)	ACS/ANS
B05	Toxic Room/Spent Decontamination System (TOX/SDS)	TOX/SDS
B06	Metal Parts Treater/Treatment (MPT)	MPT
B07	Dunnage Shredding and Handling (DSH)	DSH
B08	Continuous Steam Treater (CST)	CST
B09	Immobilized Cell Bioreactor (ICB)	ICB
B10	Metal Parts Treater Offgas Treatment (MPT OTS)	MPT OTS
B11	Immobilized Cell Bioreactor Offgas Treatment System (ICB OTS)	ICB OTS
B12	Brine Reduction Area (BRA)	BRA/WRS
B13	Bulk Chemical Storage and Distribution (BCS)	BCS
B14	Water Recovery System (WRS)	BRA/WRS
B15	Residue Handling Area (RHA)	RHA
B16	Continuous Steam Treater Offgas Treatment System (CST OTS)	CST OTS
B19	Secondary Heat Transfer Fluid Circulation System - Energetics	HTS
B20	Energetics Rotary Hydrolyzer Offgas Treatment System (ERH OTS)	ERH OTS
B21	Energetics Neutralization System (ENS)	ENS
B22	Energetics Transfer System (ETS)	ETS
E01	Power/Power Distribution	Facility Utilities
E02	Essential Power Supply	Process Utilities
E03	Critical Power Supply	Process Utilities
E10	Lighting	Facility Utilities
E20	Grounding/Lightning Protection System (LPS)	Facility Utilities
E30	Communications	Facility Controls
E60	Heat Tracing	Process Controls
E70	Instrumentation	Process Controls
E80	Controls	Process Controls
J01	Integrated Process and Facility Control System	Process Controls
J02	Agent Monitoring System (AMS)	Fixed Controls
J03	Continuous Emissions Monitoring System (CEMS)	Fixed Controls
J04	Facility Protection System (FPS)	Fixed Controls
J05	Process Data Acquisition & Reporting System (PDARS)	Fixed Controls
J07	Closed-Circuit Television (CCTV)	Fixed Controls
M02	Energetics Processing Building Heating, Ventilation, & Air Conditioning System	HVAC
M03	Agent Processing Building Heating, Ventilation, & Air Conditioning System	HVAC
M04	Control & Support Building Heating, Ventilation, & Air Conditioning System	HVAC
M05	Lab Heating, Ventilation, & Air Conditioning System	HVAC

System	Description	Mitretek RDT&E Category
M06	Support Facilities Heating, Ventilation, & Air Conditioning Systems	HVAC
M07	Filtration Systems	Filtration
M10	Site Water System	Utilities
M11	HVAC Hot Water System	HVAC
M12	HVAC Chilled Water System	HVAC
M13	Process Cooling Water System	Process Utilities
M14	Process Chilled Water System	Process Utilities
M15	Demineralized Water System	Process Utilities
M16	Process Water System	Process Utilities
M20	Steam Generation and Condensate System	Process Utilities
M30	Fire Protection Systems	Facility Utilities
M40	Plumbing/Drains	Facility Utilities
M50	Compressed Air/Instrument Air Systems	Facility Utilities
M51	Breathing Air System	LSS
M52	Nitrogen	Facility Utilities
M60	Natural Gas Supply	Facility Utilities
M61	Fuel Oil Supply	Facility Utilities
M80	Material Handling Systems	All/Unallocated

Table A-3 – Cost Data: Commodity Identifiers

Commodity ID	Commodity Description	Mitretek Commodity Category
11	Sitework	Structure
12	Concrete Related	Structure
13	Steel Work	Structure
14	Architectural	Structure
15	Piping Bulk	Utilities
16	Electrical Bulk	Utilities
17	Instrumentation	Process
18	Painting, Fireproofing, Insulation	Structure
21	Pumps and Drives	Utilities
22	Compressors, Blowers, Fans	Utilities
23	Heat Exchangers	Utilities
24	Tanks and Storage	Process
25	Material Handling	Process
26	Water Treatment	Utilities
27	Mechanical Equipment	Utilities
28	Electrical Equipment	Utilities
31	Process Equipment	Process
33	Precipitators, Baghouses	Process

Table A-4 – Cost Data: Mitretek MCD Cost Categorization

Facility Description	Cost ($)	Mitretek Facility Category	Consolidated Cost ($)
Utilities, Under Ground Utility Building (UB) Utilities, Above Ground Mechanical & Electrical Building (MEB) Fuel Oil Storage (FOS) Standby Diesel Generator (SDG)	[redacted]	Utilities	[redacted]
Energetics Processing Building (EPB)	[redacted]	EPB	[redacted]
Agent Processing Building (APB)	[redacted]	APB	[redacted]
Personnel Maintenance Facility (PMB) Maintenance Building (MB) Miscellaneous / Holding Account Warehousing Outside Fence (WOF) Gas Mask Storage Building (GMS) Entry Control Facilities (ECFs)	[redacted]	Ancillary	[redacted]
Demilitarization Filter Area (DFA) Filter Electrical Building (FEB)	[redacted]	DFA	[redacted]
Site Preparation / Improvements	[redacted]	Site Prep	[redacted]
Post Neutralization Building & Equipment Biotreatment Area (BTA) BTA Electrical Building (BEB)	[redacted]	Post Neut	[redacted]
Process Auxiliary Building (PAB)	[redacted]	PAB	[redacted]
Control and Support Building (CSB)	[redacted]	CSB	[redacted]
Laboratory/Lab Filter Area (Lab/LFA)	[redacted]	Lab	[redacted]
Waste Storage Building (WSB)	[redacted]	WSB	[redacted]
Grand Total	[redacted]		[redacted]

Table A-5 – Cost Data: Mitretek RDT&E Cost Categorization

Mitretek System ID	Cost ($)	Mitretek Facility Category	Consolidated Cost ($)
ACS/ANS	[redacted]	APB	[redacted]
MWS	[redacted]		
MPT OTS	[redacted]		
MPT	[redacted]		
Controls	[redacted]		
All	[redacted]		
TOX/SDS	[redacted]		
Utilities	[redacted]		
Process	[redacted]		
BCS	[redacted]		
HVAC	[redacted]		
RHA	[redacted]		

Mitretek System ID	Cost ($)	Mitretek Facility Category	Consolidated Cost ($)
CST OTS	[redacted]	EPB	[redacted]
Utilities	[redacted]		
CST	[redacted]		
PHS	[redacted]		
ERH/HDC	[redacted]		
Controls	[redacted]		
All	[redacted]		
DSH	[redacted]		
ETS	[redacted]		
ERH OTS	[redacted]		
Process	[redacted]		
ENS	[redacted]		
PRA	[redacted]		
PHS Bypass	[redacted]		
ENS HTS	[redacted]		
RHA	[redacted]		
TOX/SDS	[redacted]		
BCS	[redacted]		
BRA	[redacted]		
Controls	[redacted]	CSB	[redacted]
All	[redacted]		
Utilities	[redacted]		
ICB	[redacted]	Post Neut	[redacted]
ICB OTS	[redacted]		
Utilities	[redacted]		
All	[redacted]		
Controls	[redacted]		
Process	[redacted]		
BRA	[redacted]	PAB	[redacted]
WRS	[redacted]		
Process	[redacted]		
Utilities	[redacted]		
All	[redacted]		
BCS	[redacted]		
ENS HTS	[redacted]		
Controls	[redacted]		
RHA	[redacted]		
ACS/ANS	[redacted]		
DFA	[redacted]	DFA	[redacted]
Utilities	[redacted]		
Controls	[redacted]		
All	[redacted]		
Process	[redacted]	Utilities	[redacted]
Controls	[redacted]		
All	[redacted]		
Utilities	[redacted]		
BCS	[redacted]		
ICB	[redacted]		
Process	[redacted]	Ancillary	[redacted]
Utilities	[redacted]		

Mitretek System ID	Cost ($)	Mitretek Facility Category	Consolidated Cost ($)
All	[redacted]		
Controls	[redacted]		
All	[redacted]	Lab	[redacted]
HVAC	[redacted]		
Grand Total	[redacted]		[redacted]

A.2 Construction Cost Assessment: MCD Portion

The MCD portions of the PT&C cost data is facility (or building) specific—costs are not allocated by system (see Table A-2 – Cost Data: System Identifiers on page 123). Other facility estimates (e.g., USACE) are based on a historical cost-per-square foot factor multiplied by the size of the EPB and APB. This section discusses Mitretek's assessment of these methods and provides Mitretek's approach.

A.2.1 Facility Construction Cost Factors

A.2.1.1 Cost by Construction Type

One notable issue observed by Mitretek relates to cost assessments that assume common construction. Chemical demilitarization facilities have basic industrial construction, but incorporate more expensive construction features of certain operating areas. Most notably, the costs associated with liquid, vapor, and explosion containment are significant drivers.

Liquid/vapor containment can apply to any hazardous chemical, but represents a special design challenge when applied to lethal chemical agents. Vapor containment is represented by contamination categories, as discussed in Table A-6 on page 128. Special ducting, dampers, and controls are incorporated to achieve the specific cascaded air flow from less contaminated areas to more contaminated areas (e.g., "C" to "B" to "A").

In addition to agent containment, explosion containment may be required depending on the operation. Explosion containment represents extreme construction, incorporating fragment and blast overpressure structures and controls. The combination of agent and explosion containment is referred to as "total containment". For example, the PMD ECR has total containment: It has 25-inch thick, heavily reinforced concrete walls and ceiling with steel transfer gates and vault doors, it is air-tight, and its HVAC equipment is hardened with blast valves/dampers and attenuation ducts.

Given these significant differences, construction costs must be evaluated by the type of construction whenever possible. Figure A-1 on page 129 shows the relative costs associated with typical structures at a chemical demilitarization site. As depicted (and expected), costs dramatically increase as certain architectural features are added. The cost of explosion containment can increase the cost of an area from several times to nearly an order of magnitude.

Table A-6 – Chemical Agent Contamination Containment Features

Conta-mination Category	Probability of Agent Contamination: Liquid	Probability of Agent Contamination: Vapor	Typical Type of Operation	Containment Design Features
A	High (Routine)		Toxic	• Usually more robust architectural features for liquid agent containment with chemical resistant coating (all surfaces) • Negative pressure by cascaded HVAC with carbon filtered exhaust system
A/B	"A" or "B" depending on operating conditions		Toxic	• Comparable to Category "A", above, possibly not as robust architectural features
B	Unlikely	High (Routine)	Toxic	• Standard architectural features with chemical resistant coating (all surfaces) • Negative pressure by cascaded HVAC with carbon filtered exhaust system
C	Unlikely	Low	Attended Process Activities; Observation Corridors; Secondary Containment	• Standard architectural features with chemical resistant coating (floor only), standard paint elsewhere • Negative pressure by cascaded HVAC with carbon filtered exhaust system
D	Unlikely		Common Industrial Activities, Vestibules, etc.	• Standard architectural features • Atmospheric pressure (no cascaded HVAC)
E	Prevented		Control Room (CON); DPE Support Area (DSA)	• Standard architectural features • Positive pressure by carbon filtered HVAC air supply

A.2.1.2 Building Cost by "Square Foot"

Another notable issue observed by Mitretek relates to cost assessments made purely on facility size using a standard cost per square foot (SF). Many top-level cost assessments have estimated facility cost by using the total square footage of the facility and multiplying it by a standard cost per square foot based on a comparable baseline incineration facility. For example, the cost of common industrial construction, such as an equipment room, can be grossly overestimated. Similarly, the cost of expensive architectural features, such as total containment (i.e., agent and explosion containment), can be grossly underestimated.

Such an approach misrepresents the actual cost of the facility, especially for the PCAPP, which has a significantly different distribution of contamination categories. Applying baseline incineration MDB-based costs to comparable PCAPP facilities, without adjusting for the actual type of construction, results in errors. As shown in Table A-7 on page 130, baseline incineration has a greater percentage of category A-type construction while PCAPP has a greater percentage category "C" area. Since category "A" construction is significantly more expensive, applying baseline MDB-based estimates to PCAPP would overestimate the actual total facility cost.

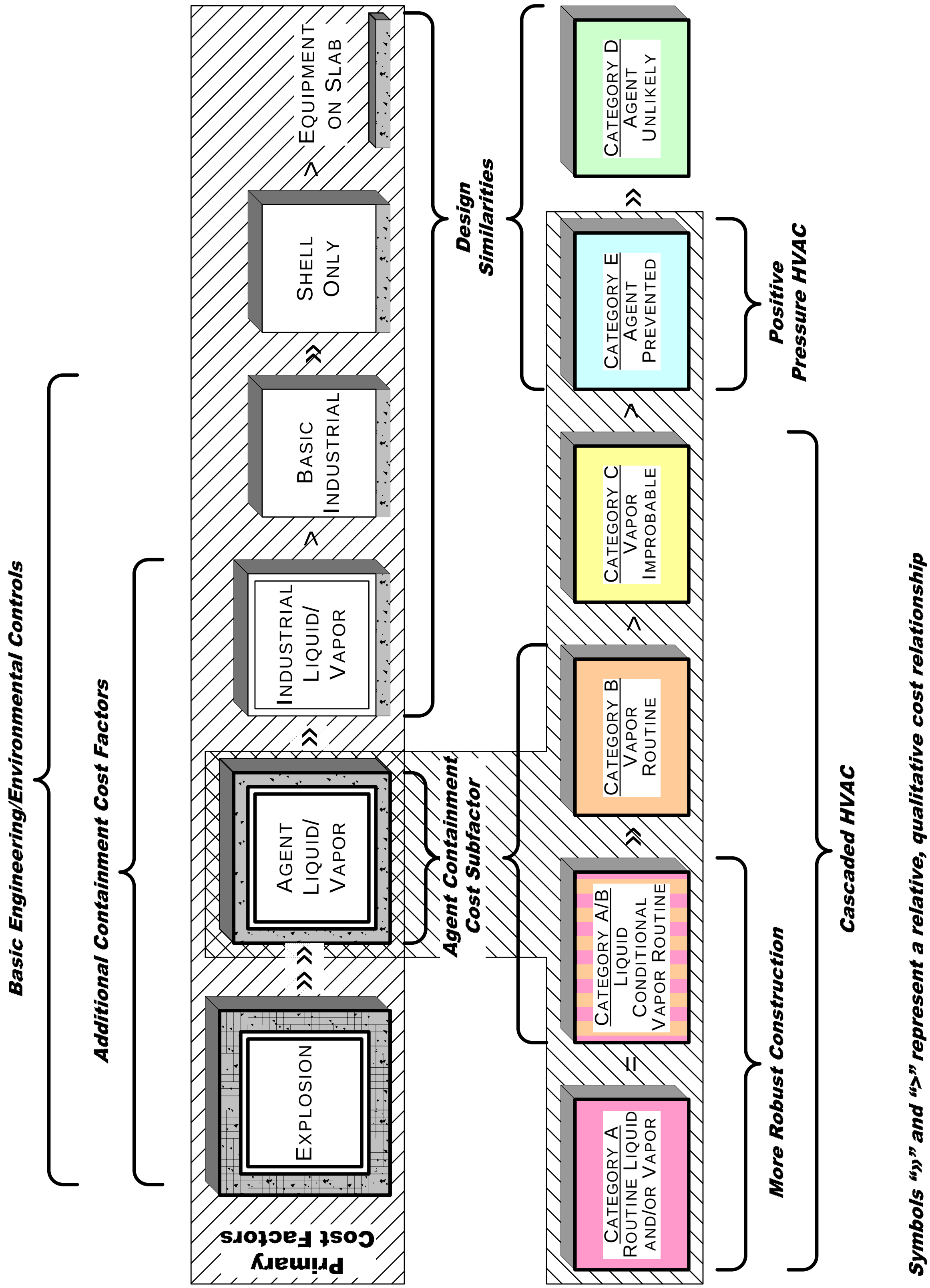


Figure A-1 – Cost Factors for Chemical Demilitarization Building Construction

Table A-7 – Floor Space Comparison of Baseline Incineration to PCAPP by Containment Construction

Chemical Demilitarization Buildings	A	A ECR	B	B ECR	C	D	E	Total SF
PCAPP combined EPB, CSB, CEA, & APB	39,895		41,375	9,180	115,100	76,840	15,180	297,580
Percentage of Total	13%		14%	3%	39%	26%	5%	
Baseline Incineration Munitions Demilitarization Building (MDB)	21,775	1,760	11,660		18,510	20,885	3,475	78,065
Percentage of Total	28%	2%	15%		24%	27%	4%	

(1) Based on Mitretek's estimate of floor space for PCAPP and TOCDF

A.2.2 Mitretek's Facility Construction Cost Approach

It must be noted that sometimes designs are conceptual without adequate details to ascertain even contamination categories, let alone accurate facility square footages. Estimates made at this level are subject to significant error, but provide the only means of estimation. Fortunately, the PCAPP intermediate design is at a level of detail that allows assessment by construction feature.

In an effort to capture more realistic cost savings for the PCAPP processing alternatives, Mitretek developed weightings of the facility structure cost by construction type. Many factors comprise construction costs for a chemical demilitarization facility, but based on PT&C's cost spreadsheet for PCAPP, it can essentially be divided into three major portions:

- [redacted] Structure
- [redacted] HVAC
- [redacted] Other (plumbing, power/electrical, communications, etc.)

The primary factor affecting cost per SF of these facilities is vapor and explosion containment. In order to properly account for the construction features noted above, Mitretek developed a cost per SF by construction feature that assigns cost by contamination category and explosion containment (Category "B" only for PCAPP) rather than a blanket cost per SF for the facility as a whole. This approach better represents actual cost differences of facility downsizing that result from some of the PCAPP alternatives. The costs by construction type are presented in Table A-8 on page 131. Using these numbers and the square footage numbers (presented earlier in §2 on page 13) provide facility costs comparable to those in the IGCE (Mitretek's approach results in the EPB about [redacted] higher and the APB is [redacted] lower than the IGCE). The EPB and APB cost "savings" for each major alternative are provided in Table A-9 on page 131.

Table A-8 – Mitretek's Facility MCD Construction Cost per Square Foot

Contamination Category	Mitretek PCAPP Cost per Square Foot ($/SF)			
	Structure	HVAC	Other	Total
A or A/B	[redacted]	[redacted]	[redacted]	[redacted]
B ECR	[redacted]	[redacted]	[redacted]	[redacted]
B	[redacted]	[redacted]	[redacted]	[redacted]
C	[redacted]	[redacted]	[redacted]	[redacted]
D	[redacted]	[redacted]	[redacted]	[redacted]
E	[redacted]	[redacted]	[redacted]	[redacted]

For comparison, IGCE PCAPP facility cost divided by floorspace:
EPB = [redacted]
APB =

Table A-9 – Mitretek MCD Alternatives EPB and APB Cost Savings ($Millions)

		Contamination Category/Containment Feature						
		A	B ECR	B	C	D	E	
Cost per SF	($)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Changes								Totals
2-Line	(ft^2)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	($M)							
Offsite Dunnage Disposal	(ft^2)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	($M)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2-Line with Offsite Disposal	(ft^2)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	($M)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

A.2.3 Mitretek's Alternative Facility Cost Findings

A.2.3.1 MCD Costs

Using the approach discussed previously results in the MCD cost of the alternatives provided in Table A-10 on page 132. Rationale explaining the approach for each facility is also provided. The Process Auxiliary Building (PAB) is not expected to change in size as a result of process reductions, just its capacity. However, this capacity change is not expected to significantly affect the facility. Conversely, additional features required for handling waste propellant in the Waste Storage Building (WSB) will require significant increases since the WSB was designed for inert, non-flammable/non-explosive wastes. Finally, costs associated with the Demilitarization Filter Area (DFA), the carbon filtration system for agent containment, are only reduced for the reductions in Category "A", "B", and "C" areas.

Table A-10 – Mitretek MCD Cost Findings for Alternatives

		2-Line Process		
Facility	**3-Line**	**Change**	**Cost**	**Rationale**
EPB	[redacted]	[redacted]	[redacted]	Square footage change (based on Mitretek drawing analysis) multiplied by Mitretek's estimated cost per square foot
APB	[redacted]	[redacted]	[redacted]	
DFA	[redacted]	[redacted]	[redacted]	Percentage of category A/B/C area change (based on Mitretek drawing analysis)
PAB	[redacted]	[redacted]	[redacted]	Mitretek estimate of equipment reduction
			[redacted]	2-Line MCD Change
			[redacted]	3-Line MCD Cost
			[redacted]	2-Line MCD Cost
			[redacted]	Change

		Offsite Disposal		
Facility	**3-Line**	**Change**	**Cost**	**Rationale**
EPB	[redacted]	[redacted]	[redacted]	Square footage change (based on Mitretek drawing analysis) multiplied by Mitretek's estimated cost per square foot
DFA	[redacted]	[redacted]	[redacted]	Percentage of category A/B/C area change (based on Mitretek drawing analysis)
PAB	[redacted]	[redacted]	[redacted]	Mitretek estimate of equipment reduction
WSB	[redacted]	[redacted]	[redacted]	Mitretek estimate for additional floorspace and improved fire suppression system (for propellant storage and handling)
			[redacted]	2-Line MCD Change
			[redacted]	3-Line MCD Cost
			[redacted]	2-Line MCD Cost
			[redacted]	Change

		2-Line with Offsite Disposal		
Facility	**3-Line**	**Change**	**Cost**	**Rationale**
EPB	[redacted]	[redacted]	[redacted]	Square footage change (based on Mitretek drawing analysis) multiplied by Mitretek's estimated cost per square foot
APB	[redacted]	[redacted]	[redacted]	
DFA	[redacted]	[redacted]	[redacted]	Percentage of category A/B/C area change (based on Mitretek drawing analysis)
PAB	[redacted]	[redacted]	[redacted]	Mitretek estimate of equipment reduction
WSB	[redacted]	[redacted]	[redacted]	Mitretek estimate for additional floorspace and improved fire suppression system (for propellant storage and handling)
			[redacted]	2-Line MCD Change
			[redacted]	3-Line MCD Cost
			[redacted]	2-Line MCD Cost
			[redacted]	Change

A.3 Construction Cost Assessment: RDT&E Portion

The RDT&E portions of the PT&C cost data is provided by system (see Table A-2 – Cost Data: System Identifiers on page 123). Previous alternative estimates used varying degrees of cost analysis from breakdown of associated expenditures to “off the top” percentage reductions. This section discusses Mitretek’s approach and assessment of these methods.

A.3.1 Mitretek Approach

Mitretek’s adjustment of the RDT&E data for alternatives involved both reductions in equipment and facilities. Mitretek used is engineering judgment to assign reductions (adjustment factors in percentage) for each system affected by each alternative. These reductions were mostly based on estimated equipment reduction. Sometimes the reduction involves a physical reduction (capacity or quantity) of the equipment while other times it is a general facility reduction, which must be taken “off the top”. It should be noted that this approach is not as straightforward as expected. For example, reducing a process line from three units to two does not necessarily reduce the cost by a third due to common equipment use, such as upstream and downstream transfer systems; the actual reduction may only one quarter. Mitretek took this into account in its estimates for direct process-specific (e.g., CST, MWS, etc.) reductions. Some of the System IDs shown in Table A-5 on page 125 are not process specific, such as “Utilities”, “Controls”, “Process”, or “All”. In this case, Mitretek used a general facility reduction estimate (a percentage “off the top”) for each alternative.

Physical equipment reduction quantities for alternatives are shown in Table A-11 on page 134. It should be noted that there is no physical reduction of equipment for offsite propellant disposal and the 1-line alternative is included for information only as it relates later to §A.4.1 on page 138.

System reductions (percentages) and cost savings for each alternative are provided in Table A-12 on page 136. It should be noted that the each alternative, 2-line, dunnage, and propellant, is listed separately and their respective, unique reductions listed; their sum giving the savings associated with the recommended Mitretek process.

Table A-11 – Equipment Changes for Alternatives

Facility	Process	System	Units	Equipment List	3-Line	Changes from 3-Line			Comments
						2-Line	Offsite Dunnage	1-Line	
EPB	UPA	B01	Forklifts		7	-1	-2	-2	
			All Equipment	Conveyor (10), APE, Airlock Conveyors (3), Carts	1				Integral system
	Reconfiguration		PMD Feed Station	Crane, Conveyor, Airlock Conveyor	3	-1		-2	
	Energetics Accessing		PMD Feed System	Conveyor (2), Blast Gate	3	-1		-2	
			PMD	Robot, NCRS, MPRS, BRS	3	-1		-1	1-Line = 2 each NCRS, MPRS, and BRS (in one ECR)
			PMD Projectile Discharge	Conveyor (3), Blast Gate, Robot	3	-1		-2	
			Tray Bypass Line	Conveyor (4), Airlock Conveyor	2	-1		-1	
			Tray Transfer System	AGV Conveyor (3)	1				2-line or 1-line = Shortened with only 2 AGVs
			PMD Energetics Discharge	Conveyor (4), Blast Gate, ETS Transfer Station	3	-1		-2	
			ETS	Pneumatic transfer system TBD	1				2-Line, 1-line, Offsite Propellant = Smaller for each
		B22	ERH Energetics Feed	ETS Transfer Station, Airlock Conveyor	2			-1	1 per ERH
	Energetics Treatment	B03	ERH-HDC	ERH, Fluid System, Heat Exchangers, HDC, Discharge	2			-1	Offsite Propellant = smaller
			ENR & ERH-HDC OTS	Conditioner/Holding Tank, Heater, CATOX, Venturi Scrubber, Pumps (2) and shared Surge Tank, Recirculation Cooler	2			-1	One, shared Surge Tank and Recirculation Cooler
		B20	ENS ENR	Reactor, Cooler, Pump	4	-1		-2	
		B21	ENS Holding Tank	Tank, Pump	2				2-Line or 1-Line = Smaller
			ENS Hoist	Overhead monorail	1				
			SHTS	Secondary Heat Transfer Fluid Circulation System	1				2-Line or 1-line = Smaller
		B19	DSH	Crane, Transfer Conveyor (3), Shredder (2), Metal Removal, Metal Bin, Storage Bin, Discharge Conveyor	2		-1		Feed/transfer and size reduction equipment
	Dunnage Accessing	B07	Carbon Feed System	Transfer Sport, Transfer Module, Feeder, Storage Bin, Discharge Conveyor	1				
			Super Sack®[1] Feed System	Unloader, Feeder, Storage Bin, Discharge Conveyor	1				
			Dust Collection System	Blower, Collector, Transfer Conveyor (Closure Baghouse)	1				

[1] Super Sack® is a registered trademark of B. A. G. Corporation, 11510 Data Drive, Dallas, TX 75218 USA

Facility	Process	System	Units	Equipment List	3-Line	Changes from 3-Line			Comments
						2-Line	Offsite Dunnage	1-Line	
			CST Feed System	Vibratory Conveyor, Belt Conveyor, Screw Conveyors, Classifiers	3		-2		
	Dunnage Treatment	B08	CST Supply	Steam Superheaters, air reheater	2				Shared Air Reheater
			CST	CST	3		-2		
			CST Discharge System	Cooling Screw Conveyor, Vibratory Classifier, Screw Conveyor, Disposal Tote Bin	3		-2		
			CST OTS 1	Heaters, Cyclone, Pre-Catalytic Bed, CATOX	3		-2		
		B16	CST OTS 2	Blower (2), Pump (2), Filter	2		-1		Shared for 3 CSTs
			CST OTS 3	Air Reheater, Venturi Scrubber, Surge Tank, Cooler	1				Shared for 3 CSTs
			EPB Electrical	Industrial power distribution equipment	8	-1	-1	-2	Guesstimate
	Utilities		CST Electrical	Industrial power distribution equipment	11		-7		
			HVAC	Air Handling Units (AHUs)	4				Smaller with facility size decrease
			MWS Supply System	Pumps, storage tank	2				Shared tank; 2-Line = Smaller
APB	Agent Accessing	B02	MWS Feed System	Conveyors (3), Airlock Conveyor	3	-1		-2	
			MWS Robot	Articulated Arm Robot (1 per line)	3	-1		-2	
			MWS CAM	Accessing/Washing (155-mm = 3 ea; 105-mm = 4 ea; 4.2-inch = 5 ea)	12				CAMs are munition specific and need to be purchased in quantity regardless of number of lines.
			MWS Offgas Collection	Blower, Carbon Filter, Heat Exchanger (Shared)	2			-1	2-Line or 1-line = Smaller or remove redundancy
			MWS Discharge System	Conveyor	3	-1		-2	
			MPT Buffer/Feed System	Airlock conveyor (5)	3	-1		-1	
	Agent Treatment	B06	MPT	Feed Airlock Conveyor, MPT, Discharge Airlock Conveyor	3	-1		-1	
			MPT Cooldown Conveyor	Transverse Conveyor	1				Shortened for 2-line
			MPT OTS 1	Preheaters, Effluent Heaters, Cyclone, Pre-Catalytic Bed, CATOX, Cyclone	3	-1		-2	
		B10	MPT OTS 2	Steam Superheater, Blower, Filter,	2			-1	Shared for 3 MPTs
			MPT OTS 3	Conditioning Tank, Pump, Venturi Scrubber, Cooler, Preheater	1				Shared for 3 MPTs
			MWS Wash Collection	Separator Tank, Water Collection Tank, Agent Pump (and Spare), Water Pump (and	2			-1	2-Line = Smaller

Facility	Process	System	Units	Equipment List	3-Line	Changes from 3-Line: 2-Line	Changes from 3-Line: Offsite Dunnage	Changes from 3-Line: 1-Line	Comments
				Spare)					
		B04	ANS	Reactor, Pump (and Spare)	4	-1		-2	
		B04	Hydrolysate Collection	Holding Tank, Feed Pump, Spare Pump, Hot Water Tank (Shared)	2				2-Line or 1-line = Smaller
		B04	TOX	Conveyor, Airlock Conveyor, Monorail	1				
		B05	SDS	Holding Tank, Feed Pump, Spare Pump	3	-1		-1	
		B05	APB Electrical	Industrial power distribution equipment	4			-1	
	Utilities		HYD	(Hydraulic pump system)	1				
	Utilities		HVAC	AHU	6	-1		-2	
	Utilities		ICB Module	Tanks (4) and circulatory systems	6	-1		-3	
BTA	Post-Treatment	B09	30-Day Holding	Tank, pump	3			-1	2-Line = Smaller
BTA	Post-Treatment	B09	LN2 Supply	Tank, Compressor, Vaporizor	1				2-Line or 1-line = Smaller
BTA	Post-Treatment	B09	Cooling System	Towers, Pump (1/2)	6	-1		-3	
BTA	Post-Treatment	B09	Brine Concentrator	Tank, pump (1/2)	4			-1	2 pumps shared
BTA	Post-Treatment	B09	Nutrients	Tank, Pump (2)	2				
BTA	Post-Treatment	B09	BEB	(Electrical)	1				
BTA	Post-Treatment	B09	BTA Offgas Treatment	Blower, Filter, Stack, Heater, Cooler/Condenser	6	-1		-3	Cooler/Condenser shared
BTA	Post-Treatment	B11	BRA	Tank, pump (1/2)	4			-2	2 pumps shared
PAB	Effluent Management	B12	BRA	Tank, pump (1/2)	4			-2	2 pumps shared
PAB	Effluent Management	B14	WRS	Tank (2), Compressor, Evaporator/Crystallizer, Flash Drum, Condenser	2			-1	2-Line = Smaller

Table A-12 – RDT&E Cost Reductions by System for Each Alternative

Facility ID	System ID	3-Line Cost	2-Line Reduction	2-Line Cost	Offsite Dunnage Disposal Reduction	Offsite Dunnage Disposal Cost	Offsite Propellant Disposal Reduction	Offsite Propellant Disposal Propellant Cost
EPB	CST OTS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	CST	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	PMD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	All/Unallocated	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	ERH/HDC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	DSH	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	ETS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	ERH OTS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	ENS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	PHS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	PHS Bypass	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	PRA	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Fixed Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HTS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

			2-Line		Offsite Dunnage Disposal		Offsite Propellant Disposal	
Facility ID	System ID	3-Line Cost	Reduction	Cost	Reduction	Cost	Reduction	Propellant Cost
	RHA	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	LSS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	BCS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	BRA/WRS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
APB	ACS/ANS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	MWS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	MPT OTS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	MPT	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	All/Unallocated	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	TOX/SDS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Fixed Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	BCS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	LSS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HVAC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	RHA	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
CSB		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
DFA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PAB	BRA/WRS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	All/Unallocated	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	BCS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HTS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	RHA	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Fixed Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	ACS/ANS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	LSS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Post Neut	ICB	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	ICB OTS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	All/Unallocated	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Process Utilities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Facility Controls	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Lab	(All)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Utilities	(All)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Ancillary	(All)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]		[redacted]		[redacted]	[redacted]	[redacted]
	Total Cost	[redacted]		[redacted]		[redacted]	[redacted]	
	Cost Savings			[redacted]		[redacted]	[redacted]	
	Percent Savings			[redacted]		[redacted]	[redacted]	

2-Line with Offsite Dunnage & Propellant Disposal	Total Cost	[redacted]
	Cost Savings	[redacted]
	Percent Savings	[redacted]

A.4 Other Alternatives

Alternatives and Mitretek's selection approach are provided in §2 on page 13. This appendix provides other alternatives that Mitretek considered but cannot endorse at this time, usually to due to lack of data. Most of these would require extensive trade studies using mass, material, and energy and throughput process modeling.

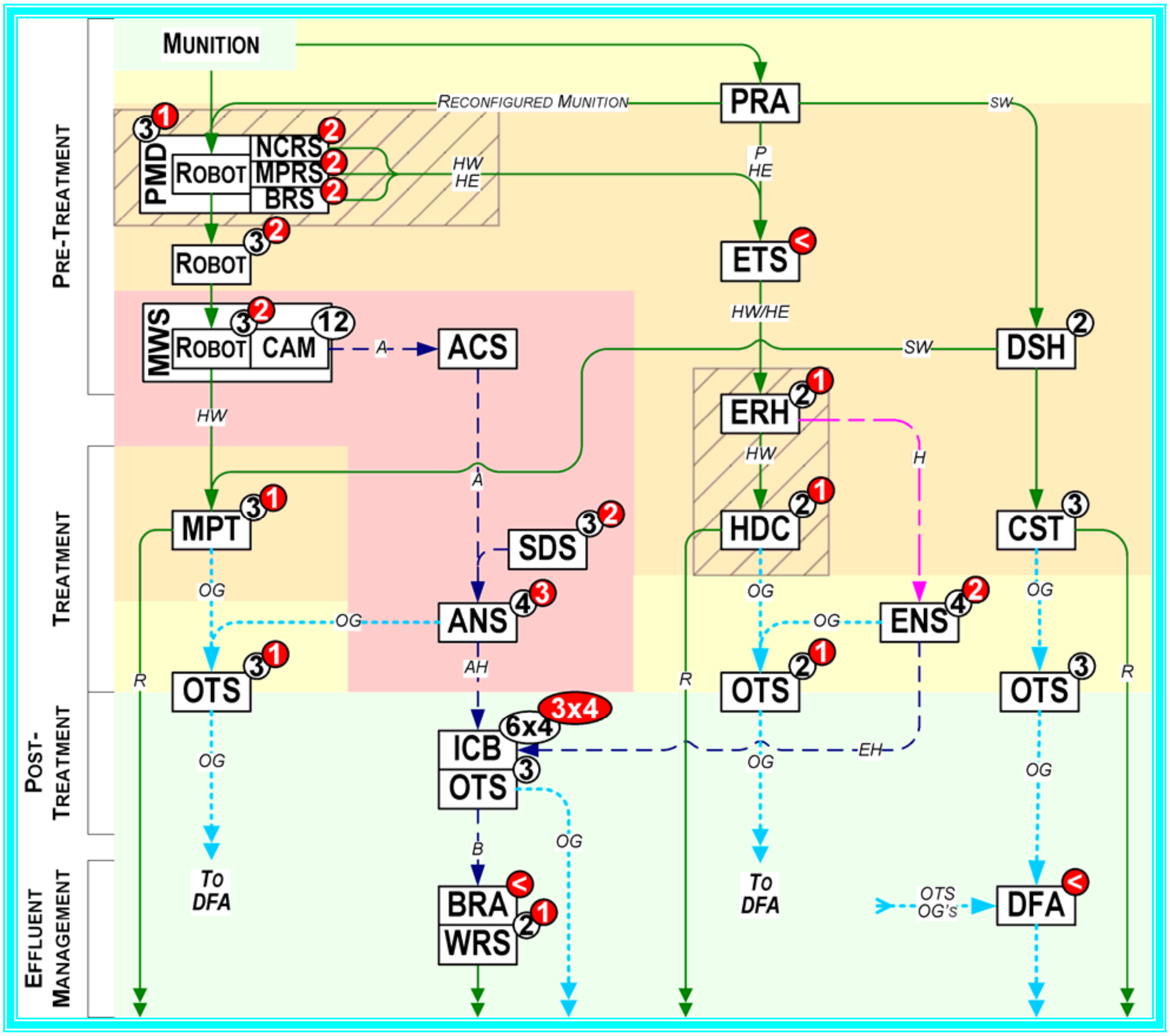
A.4.1 Process Alternatives

A.4.1.1 1-Line Process

This alternative reduces the base case design from three munition processing lines to only one. Previous AoA's indicate that a 1-line alternative would likely extend the operations schedule to an unacceptable duration but it is discussed here to document Mitretek's position on this alternative. Mitretek's approach decreases the munition processing line to one, but adds redundant reverse assembly stations at the PMD. Mitretek's 1-line BFD is shown in Figure A-2 on page 139.

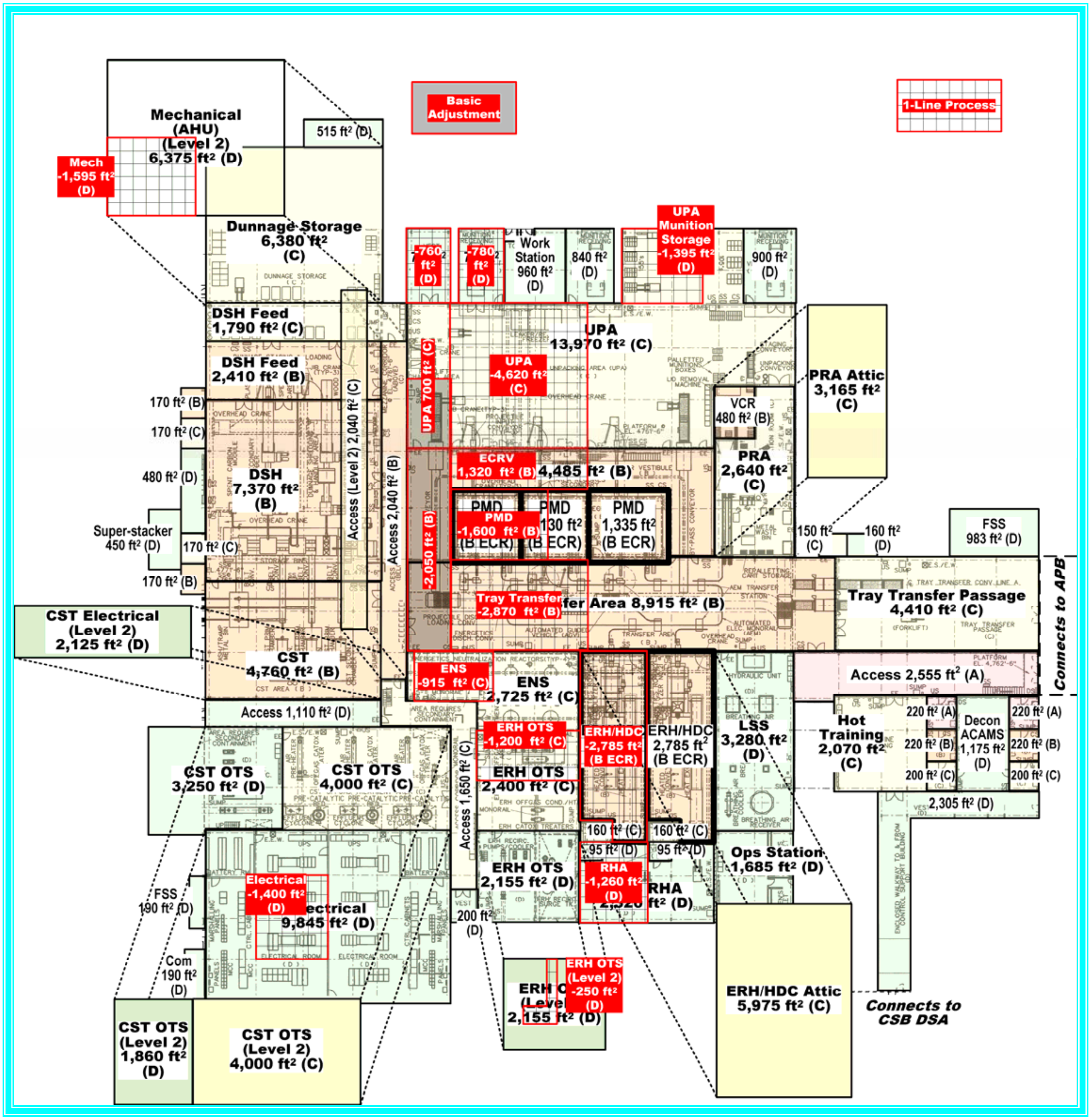
Mitretek's 1-line process would have higher construction costs than the simple 1-line process (previously considered in the AoA) due to PMD station redundancy and ECR modifications. It requires additional stations and a larger, single ECR to house this configuration. However, it is Mitretek's assessment that such a cost would be well worth the PMD downtime avoided by the simple 1-line approach. Single-point failures of munition processing are a major contributor to downtime (and lower throughputs); the PMD historically so. The lack of redundancy or backup equipment for rate limiting systems directly reduces throughput since operations must stop until the equipment is fixed, although some equipment (like the MWS) can continue operations provided there was feed buffer available.

Although the net-explosive weight (NEW) presence in the remaining ERH is lowered, the explosive blast load quantity is based on the Maximum Credible Event (MCE), which should only be comprised of a fraction of the total quantity present as well as other factors. Mitretek did not have the blast load evaluation at the time of this study, but it should be less than 10 bursters. Given the feed rate of bursters, decreasing from three processing lines to one is not likely to dramatically change the ERH ECR MCE. Therefore, Mitretek did not assume a savings in the cost of ECR construction (time and materials) for the 1-line process. It should be noted that given the high cost of explosion containment (see Table A-8 on page 131), changes in the MCE could result in a notable savings.



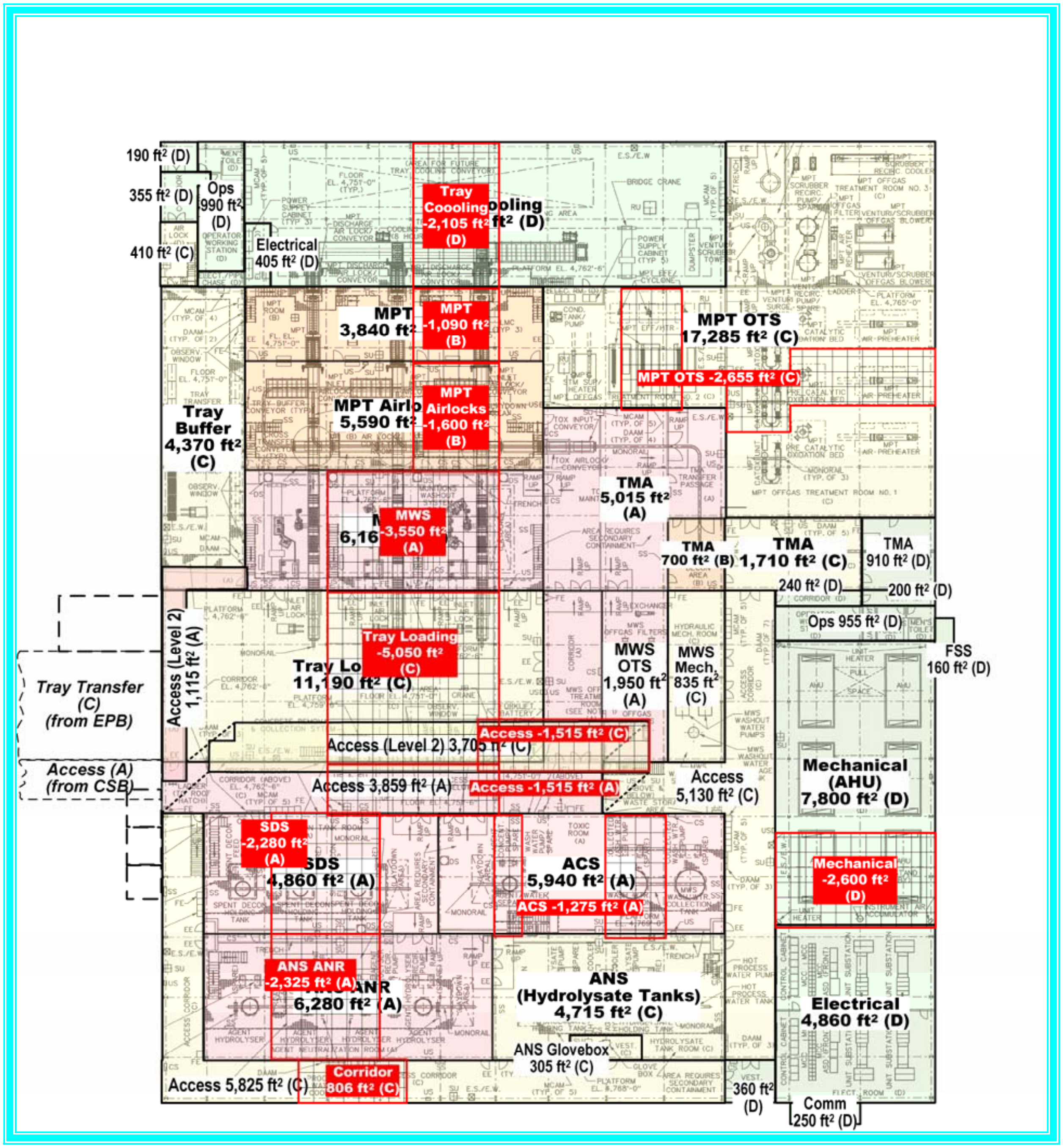
Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP)
See Table 2-3 on page 20 for acronym descriptions and legend

Figure A-2 – 1-Line Process Alternative – BFD



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP) Drawing 24852-P1-EPB-P0030
See Table 2-3 on page 20 for acronym descriptions and legend

Figure A-3 – 1-Line Process Alternative – EPB Floorspace Reductions



Source: Mitretek Systems based on PCAPP Intermediate Design (PCAPP IDP) Drawing 24852-P1-APB-P0030
See Table 2-3 on page 20 for acronym descriptions and legend

Figure A-4 – 1-Line Process Alternative – APB Floorspace Reductions

A.4.2 Offsite Disposal Alternatives

A.4.2.1 Offsite Disposal—Energetics (Propellant and High Explosives)

This alternative is offsite disposal of propellant, discussed in §2.3.2.2 on page 36, plus it ships uncontaminated high explosive (HE) components (fuzes, bursters, etc.) offsite for disposal instead of onsite treatment in the ERHs and ENS. Sending all energetics offsite could theoretically eliminate the ERH/HDCs, ERH OTSs, and ENS. However, a contingency operation is needed for agent-contaminated energetics that occur during:

- Reconfiguration – Expected to be rare occurrence expected and usually not grossly contaminated.
- Leaker processing – Expected with contamination of the burster
- Reject processing – Gross contamination of components after cutting operation; possible to surface decontaminate

Surface decontamination of explosive components may be difficult and offsite disposal of cut components from reject processing could be problematic.

The options are to keep a single energetics hydrolysis line (on standby or for a special campaign) or find another treatment alternative. The FOCIS report discusses the option of keeping one energetics treatment line (ETS, ERH/HDC, ERH OTS, and ENS). There are other technologies that could be implemented for the occasional energetic components, such as the Explosive Destruction System (EDS) currently used by CMA for non-stockpile CWM. There should be no technical barrier for use of the EDS type system, but it would undoubtedly require additional evaluation, approvals, and environmental permitting.

As noted in the FOCIS report, there are safety and environmental issues and reportedly the local community is against shipping HE components offsite. Also noted are significant cost savings, which could be even greater if an EDS-type device could be incorporated. However, given the complications and uncertainties of offsite disposal of all energetics, Mitretek cannot endorse this alternative at this time. As such, Mitretek did not assess this alternative further and does not recommend further study.

A.4.2.2 Offsite Disposal—Agent Hydrolysate

This alternative ships agent hydrolysate offsite for disposal instead of onsite treatment in the ICBs, reducing the size of the BTA. This is discussed in detail in the FOCIS report as Option 4, but it combines this with offsite disposal of energetics (discussed above). At noted in the FOCIS report, there are significant benefits to this alternative but these are overshadowed by the complications associated offsite hydrolysate disposal and further complicated by offsite disposal of energetics, as discussed above. Verifying these issues are the overwhelming complications with NECDF's recent attempts at offsite disposal of VX agent hydrolysate, but it must be noted that the properties of VX hydrolysate are different from that of HD hydrolysate. Further, mustard hydrolysate at ABCDF is being successfully transported to an out-of-state TSDF. Intense public opposition to offsite disposal of agent hydrolysate has been observed at other sites. In addition, as noted in the FOCIS report, there does not seem to be a local TSDF to accept the waste so there is unlikely to be local support for this alternative either. Given this, Mitretek cannot endorse this alternative—it is also Mitretek judgment that offsite agent hydrolysate disposal is very unlikely to ever be politically feasible. As such, Mitretek did not assess this alternative further and does not recommend further study.

A.4.2.3 Offsite Disposal—Energetics Hydrolysate

This alternative ships agent and energetics hydrolysates offsite for disposal instead of onsite treatment in the ICBs, reducing the size of the BTA. It is uncertain whether energetics hydrolysate will have the same level of political sensitivity that agent hydrolysate does, but offsite disposal of any hydrolysate from these facilities is likely to be infeasible. Mitretek cannot endorse this alternative—it is also Mitretek's judgment that offsite energetics hydrolysate disposal is unlikely to ever be politically feasible. As such, Mitretek did not assess this alternative further and does not recommend further study.

A.4.2.4 Offsite Disposal—Agent and Energetics Hydrolysate

This alternative ships all hydrolysate offsite for disposal instead of onsite treatment in the ICBs, reducing the size of the BTA. This is discussed in detail in the FOCIS report as Option 5. Offsite disposal of both agent and energetics hydrolysate would eliminate the BTA entirely. This combines the savings of the above two offsite disposal options, but is likely to be infeasible for the same reasons cited above.

A.4.2.5 Offsite Disposal—Metal Parts

This alternative ships uncontaminated and surface decontaminated (IAW an approved Equipment Decontamination Plan to health-based criteria for the new AELs) metal parts offsite for disposal instead of treatment in the MPT. This is presented as Option 6 in the FOCIS report, which proposes to eliminate all MPTs in favor of surface decontamination. Although this is feasible for munition bodies, it is Mitretek's judgment that at least one MPT will be needed to process secondary waste and other materials that cannot be surface decontaminated. In addition, a sensible facility closure schedule will likely require two MPTs. This alternative poses a number of uncertainties regarding the actual savings and technical feasibility. Mitretek cannot endorse this alternative at this time. As such, Mitretek did not assess this alternative further and does not recommend further study.

Appendix B Life Cycle Phases

The following discussion is to provide the casual reader an understanding of the life-cycle phases of a typical baseline chemical demilitarization facility (CDF). Innovative strategies used by PM ACWA are not reflected.

Table B-13 – Description of Typical CDF Life Cycle Phases

Phases	Description of Events	Scheduling Considerations
1. Pre-Contract Government Activities	Program planning, acquisition/contractor selection, etc. This may include drafting the preliminary engineering design package and submittal of a RCRA permit before a contractor is selected.	~2 years Contact award milestone ~6 months later
2. Design & Engineering	Pre-construction activities.	Many of these items overlap except for the regulatory approval, which is the critical path
2.1. Design & Engineering	Generation of the engineering design package (EDP). • Site Infrastructure Design • Detail Design (Buildings) • Detail Design (Process) Equipment procurement	~2 years from contractor selection and must be completed for RCRA permit approval
2.2. Site Safety Submission	As required: Health Hazards Analysis (HHA)	Milestone submitted at a contract-specified design level
2.3. Regulatory Approval		Simultaneous with Pre-Contract Government Activities and Design & Engineering
2.3.1. Notice of Intent (NOI)	The NOI is the first, formal step in the NEPA process. It is a short document (less than 5 pages) notifying the public of the Army's intent to publish an EIS and the opportunities for public involvement.	Milestone submitted at a contract-specified time
2.3.2. Scoping Process	Designed to solicit public comment on issues or concerns that should be addressed early in the EIS process. During the scoping process, the Army seeks, with public involvement, to identify significant issues related to the proposed action. The Army desires information on (1) the potential chemical weapons stockpile sites and surrounding areas, (2) concerns regarding the testing and/or operation of multiple technologies at these sites, (3) issues regarding the scale of the pilot test facilities, and (4) specific concerns regarding any potential technologies. These issues are included in the EIS (below).	Starts ~45 days following the NOI
2.3.3. Environ-mental Impact Statement (EIS)	In compliance with the NEPA (Title 40, Code of Federal Regulations, Parts 1500 through 1508), the Army prepares an EIS to assess the health and environmental impacts of the design, construction, and operation of a facility to destroy the CWM. The EIS is made public through a Notice of Availability (NOA) as well as through the media. An EIS is a comprehensive document that discusses the environmental and socioeconomic impacts of the operation. There are programmatic and site-specific EISs: programmatic deal with all sites while site-specific address only a specific site. The Draft EIS is published for public comment. There are public meetings to discuss the DEIS. Public comments are included in the final, published version with responses. Notification of the Final EIS is done with a NOA.	Writing can start anytime, but takes about 10 months. Draft Public Comment: 30 days required, but routinely extended to as long as 60 days Final: 30-day waiting period for additional comments

Phases	Description of Events	Scheduling Considerations
2.3.4. Record of Decision (ROD)	While the EIS discusses all options (even "No Action"), the ROD officially announces the plan of action (i.e., technology selection, all things considered) from the EIS. The ROD describes the DOD's decision regarding the proposed action, identifies potential problems, explains any uncertainties, and identifies the type and extent of impacts that might occur. The ROD also describes actions to be taken by DOD to reduce or mitigate any significant adverse impacts associated with its decision. Everything to this point will also be impacted by the creation of the Defense Acquisition Board (DAB). The DAB advises the Department of Defense on critical acquisition decisions and conducts reviews at major program milestones. The DAB review supports oversight and informed decision-making regarding the Chemical Stockpile Disposal Program at a senior Department of Defense level. The DAB will make a recommendation on PMCD's path forward to the Under Secretary of Defense (Acquisition, Technology, and Logistics), which is of critical influence to the ROD.	Milestone document prepared at least 30 days after Final EIS NOA
2.3.5. Resource Conservation & Recovery Act (RCRA)	The generation, accumulation, treatment, storage, and disposal of nonhazardous and hazardous wastes are regulated under the *Solid Waste Disposal Act* (SWDA), as amended by the *Resource Conservation and Recovery Act* (RCRA) (42 USC 6901 et seq.) and the *Hazardous Solid Waste Amendments of 1984* (HSWA). Under §3006 of the SWDA, any state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for U.S. Environmental Protection Agency (EPA) authorization of such a program. RCRA requires public comment periods (similar to NEPA) prior to granting a permit and for modifications to the facility, unless they are quite minor modifications. Executive Order 12088, *Federal Compliance with Pollution Control Standards*, requires federal agencies (including the U.S. Army) to comply with applicable administrative and procedural pollution control standards established by, but not limited to: • *Toxic Substances Control Act* (TSCA) (15 USC 2605(e)) provides for the regulation of polychlorinated biphenyls (PCBs) • *Clean Air Act* (CAA) (42 USC 7401 et seq.) requires the EPA to establish national primary and secondary ambient air quality standards as necessary to protect public health and provide the public with an adequate margin of safety from any known or anticipated adverse effects of a pollutant. • *Clean Water Act* (CWA) (33 USC 1251 et seq.) and *Safe Drinking Water Act* (SDWA) provides that it is illegal to discharge pollutants from a point source into navigable waters of the United States except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The Endangered Species Act (16 USC 1531 et seq.) is intended to prevent the further decline of endangered and threatened species of animals and plants and to bring about the restoration of these species and their habitats. • *Noise Control Act of 1972* (NCA) (42 USC 4901 et seq.) directs all federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment that is free from any noise that jeopardizes health or welfare.	

Phases	Description of Events	Scheduling Considerations

2.3.5 Resource Conservation & Recovery Act (RCRA) (Continued)	Other Compliance Requirements:
	• *Emergency Planning and Community Right-to-Know Act of 1986* (EPCRA or *Superfund Amendments and Reauthorization Act* [SARA] Title III) (42 USC 1101 et seq.) and *Hazardous Material Transportation Act:* Industrial facilities are required to provide information, such as inventories of the specific chemicals they use or store, to the appropriate State Emergency Response Commission and Local Emergency Planning Committee (LEPC) to ensure that emergency plans are sufficient to respond to accidental releases of hazardous substances.
	• The *National Historic Preservation Act* (NHPA) (16 USC 470 et seq.) provides that locations with significant national historic value be placed on the National Register of Historic Places (NRHP).
	• *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (Executive Order 12898) calls on federal agencies to incorporate environmental justice as part of their missions, including decisions made in compliance with NEPA.
	• Army Regulations:
	  o AR 385-61 & AR Pam 385-61, *Chemical Agent Safety Program and Chemical Safety*
	  o AR 50-6, *Chemical Surety*
	  o AR 200-1, *Environmental Protection and Enhancement*
	• *Convention on the Prohibition on the Development, Production, Stockpiling, and Use of Chemical Weapons and Their Destruction* (CWC)	

3. Construction	Facility is constructed by contractors and the U.S. Army Corps of Engineers to the design package.	Cannot start until RCRA permit granted
3.1. Fabrication	• Site Infrastructure Construction • Main Destruction Building (MDB) Construction • MDB Precommissioning • Construction (non-MDB) • Precommissioning (non-MDB) • Installation • MDB-Specific Equipment • All Other Equipment	
3.2. Pre-Systemization/ Acceptance Testing	Verification that all systems work before the government accepts “ownership” as part of Construction Jurisdictional Turnover (CJTO). At this time, there is a comprehensive system inspection to verify that everything was built to design and that all engineering change orders are closed out. Pre-systemization-to-systemization custody turnovers are conducted as systems are approved. This phase also includes dry runs of certain equipment and systems for functionality.	Begins well into fabrication on individual units and later on the integrated system.

Phases	Description of Events	Scheduling Considerations
4. Systemization	Inert trials to verify integrated system operations, including materials transport and surrogate processing operations. During this time, modifications and repairs are made to ensure the system functions properly. Sometimes a standalone phase; sometimes part of the construction phase (as shown here). • Training • Systemization Sub-Phases 1,2,3 • Systemization Sub-Phases 4 (Integrated Plant Run) • Systemization Sub-Phase 5 (Optimization) • Pre-Operational Inspection ("Pre-Op"): Comprehensive inspection of the CDF by a variety of entities with specific expertise to validate that the system is ready to go "hot."	
5. Operations	All "hot" operations for the destruction of the CWM.	
5.1. Shakedown	Hot operations designed to prepare for full-scale process demonstration. Guided by the EPA RCRA permit, these usually consist of about 720 hours of operation to ramp up to full scale, with an option for an additional 720 hours (which the U.S. Army usually chooses to do). Further changes/repairs can be made at this time, but it is more difficult since operators must be in DPE if the area requiring the repair is contaminated.	
5.2. Demonstration (RCRA Trials)	Demonstration of CWM demilitarization throughput for RCRA approval. This consists of a 4-hour window where the plant demonstrates full, steady state throughput with full data collection. Three trials of 4-hours each are required, but four are usually conducted. Some states are now requiring RCRA trials be conducted with simulants for every agent munition combination prior to hot RCRA trials.	Ramp-up: 1) 1/3 to 1/2 full rate: ~4 weeks 2) 2/3 to 3/4 full rate: ~4 weeks 3) Full rate optimization: ~2 weeks 4) Full rate demonstration: ~8 weeks
5.3. Post-Demonstration (Post-RCRA Trial Period)	Immediately following RCRA trials, the EPA normally grants provisional approval to operate at reduced rate (usually 50% of demonstrated rate) while the data from the RCRA Trials is reviewed. If the facility could not operate at steady state for 4 hours, it is unlikely the EPA would grant approval for reduced rate processing. Data review can often take a number of months. Usually, the CDFs begin shakedown of a different munition, giving them 1,440 hours to attempt full rate production with a different agent or munition. For example, a shakedown of VX rockets after a RCRA Trial with GB rockets requires only a few weeks to change out agent monitoring equipment. The value of this approach is determined through a trade study.	Can take months for regulatory approval
5.4. Full-Scale Operations	Full rate CWM destruction begins with EPA approval.	
6. Closure	The decontamination and dismantling of systems, structures and components used during the course of the demilitarization effort. Decontamination can be accomplished by chemical, mechanical or thermal methods. Process equipment is removed, followed by the removal of ancillary equipment such as pipes, valves, cables and switches. Surface removal of concrete is performed where necessary. Once the decontamination and process equipment removal is completed, the process buildings are demolished.	

Appendix C Systemization Schedule Evaluation

The following represents some of the factors used to evaluate the duration of systemization by dividing them into "pros" (shortening) and "cons" (lengthening) based on a TOCDF systemization study conducted by SAIC.

C.1 Factors Shortening PCAPP Systemization

The following represent some factors that could result in making PCAPP Systemization "short" with respect to baseline experience:

- The government is planning to use same contractor team for Design/Build and Systemize/Operate. At TOCDF, Parsons, the designer, transferred the design to the operator EG&G prior to or during construction which resulted in many engineering design proposals (ECPs), which contributed to delays.
- With two separate buildings, PCAPP can begin systemization earlier than a two-story baseline facility since the one-story PCAPP buildings can be built and systemized in parallel.
- Baseline sites had to systemize for bulk agent, projectiles, rockets, and then for co-processing. At TOCDF, the integrated plant runs totaled [redacted] and were performed in series. Significant time was invested to change over the machine configurations and fully demonstrate the projectile and bulk lines. This will not be the case at PCAPP.
- PCAPP has only three physical configurations of CWM (two types of artillery shells and the single mortar shell type). Baseline incineration sites usually have many more comprised of various bulk containers, bombs, artillery shells, mortar shells, rockets, and landmines.
- PCAPP has only HD and HT. TOCDF has GB, VX, HD, and H.
- PCAPP can capitalize on lessons learned from JACADS, TOCDF, ANCDF, PBCDF, UMCDF, ABCDF, and NECDF.
- Most of the Lessons Learned from Aberdeen will be directly applicable to PCAPP.
- PCAPP is fabricating many process units modularly and testing them offsite to the extent possible.
- PCAPP is initiating pre-systemization early during the construction phase ([redacted] overlaps with construction phase).
- PCAPP is presently performing TRRP testing on four major systems: MWS, MPT, CST, ERH/HDC Interface.
- The linear PMD is designed to be more reliable and efficient than baseline PMD.
- System contractor outreach efforts to the community should minimize CSEPP delays (unlike at Anniston where there was a [redacted] delay).
- The Biological Treatment Area (BTA) can be more independently systemized from EPB/APB, unlike the baseline pollution abatement systems which require systemization in tandem with their associated furnaces.
- The systems contractor has personnel who will be responsible for systemization participating in the PCAPP design.

C.2 Factors Lengthening PCAPP Systemization

The following represent some factors that could result in making PCAPP Systemization "long" with respect to baseline experience:

- For comparison purposes, at TOCDF, systemization times for the following pieces of equipment were lengthy (PMCD 1998):
  - Phase 1, 2 and 3 (performed in semi-parallel):
    - 2 PMDs: [redacted]
    - 1 DFS: [redacted]
    - 3 MDMs: [redacted]
    - 2 LICs: [redacted] (though tested in parallel)
    - 1 MPF: [redacted]
  - Phase 4:
    - Bulk Handling System (BHS): [redacted]
    - Rocket Handling System (RHS): [redacted]
    - Projectile Handling System (artillery and mortar shells): [redacted], but another [redacted] added since MPF was already systemized in line with bulk handling system
    - Coprocessing of 2-4 lines: [redacted]
  - Phase 5:
    - ORE/Pre-Op: [redacted] which included two sub-phases of findings and corrections
- Baseline Systemization Durations
  - TOCDF systemization was [redacted] total (depending the source used; not overlapping with construction).
  - Anniston systemization was [redacted] total with [redacted] overlapping with construction, with a final pure-systemization period of [redacted] (this does not include [redacted] delay due to CSEPP issues)
  - UMCDF systemization was [redacted].
  - PBCDF systemization was [redacted].
  - ABCDF systemization ([redacted] of the size/complexity of PCAPP) took [redacted]
- PCAPP has three concurrent projectiles lines (105-mm, 155-mm, 4.2-inch) requiring some equipment to be sized and systemized for processing all three types.
- While having already processed GB and VX, TOCDF will not process mustard munitions until ~2005. Thus, the most recent mustard experience for PCAPP design is JACADS data from 1992, 1993, 1998, and 1999.
- New or first-of-a-kind (FOAK) systems (no or little maturity at full-scale) for PCAPP that could impact the systemization critical path include:
  - EPB:
    3 linear PMDs
    2 DSH
    3 CSTs with common OTS
    1 multi-station ETS

2 ERHs with dedicated and common OTS components
4 ENS ENRs
2 BRAs
2 WRSs with associated water recycle loop

- APB:
  12 MWS CAMs (five 4.2-inch mortar CAMs; four 105-mm artillery shell CAMs; three 155-mm artillery shell CAMs)
  3 Metal Part Treaters (MPTs) with dedicated and common OTS

- Systems with a higher level of maturity and probably not on critical path:
  - EPB:
    1 Projectile Reconfiguration Area (PRA) with associated Army Peculiar Equipment (APE)
    2 HDCs (directly linked with ERHs)
    2 ENS hydrolysate holding tanks
  - APB:
    4 ANS reactors (ANRs)
    3 SDS reactors
    2 ACS (2 agent/water separators and 2 washwater collection tanks)
    2 ANS hydrolysate holding tanks.
  - Other: 3 outdoor hydrolysate holding tanks, 16 ICBs with 4 associated OTSs, sludge thickening and filtration, other munitions transfer systems and robots in EPB and APB
  - Utilities: FCS and FPS, HVAC and DFA, electrical, cooling and chilled water, steam, nitrogen, hydraulics, process air, fire detection and protection, breathing air
- PCAPP has an unprecedented amount of redundancy built into the design, though some units are independent, (e.g., PMDs and MWSs will be set up to process one type of projectile and cannot switch to another type quickly if a failure occurs).
- ETS must allow transfer of energetics from any of 3 PMDs and reconfiguration room to either of 2 ERH/HDCs.
- A comparable baseline facility would only require the following major pieces of equipment (not requiring reconfiguration or dunnage treatment): 2 PMDs, 3 MDMs, 1 MPF w/ PAS, 1 LIC w/ PAS, 1 DFS w/ PAS, and BRA. Unlike baseline with little to no redundancy, there is a considerable amount of integration of all the PCAPP units that cannot fully commence until at or near the end of construction.
- Linear PMD with robot has only been conceptualized at this point and has never been built/operated.
- There is minimal experience or precedent for systemizing the PCAPP equipment with SETH, agent simulants, and simulant hydrolysates.
- With construction being more closely tied to systemization for PCAPP, any delays or conflicts with construction will have a more direct impact on the systemization schedule.
- Only steam or water are generally used during pre-systemization, while formal systemization uses process chemicals and agent/energetic surrogates.

- The PCAPP schedule may underestimate the final two significant phases of systemization. As performed at TOCDF, they are (PMCD 1998):
  - Phase 4: Integration of all demilitarization machine (disassembly) lines with the treatment systems as they would be during normal operations. Integrated Plant Runs (IPR) are completed, with simulated munitions filled with simulated agent, to demonstrate the complete demilitarization process. IPRs are run for each for the first planned combinations of agent/munition configurations that are to be destroyed.
  - Phase 5: The final phase of systemization focuses on optimizing operations of the entire facility. During this phase, the chemical demilitarization facility and its staff practice and rehearse all plant operations, and particularly contingency and emergency response simulations. The distinction between this phase and actual operations is the absence of chemical agent, although all activities in this phase are conducted as if agent were present in the CDF.
- The sampling requirements for PCAPP are expected to be more than that of baseline facilities due to the increased number of analysis methods and sheer number of samples. The fact that the laboratory ended up on the critical path (PMCD 1998) at TOCDF during systemization demonstrates a known schedule risk in systemizing the laboratory at PCAPP.
- Baseline sites have experienced problems getting fully staffed during systemization based on difficulties finding skilled workers, which could also happen at PCAPP.
- There have been delays at baseline sites in getting the environmental regulators to agree on acceptable surrogate materials, which could happen at PCAPP.

Appendix D Operations Schedule Evaluation

The capabilities and limitations of the Mitretek spreadsheet model and the BPT iGrafx model are discussed in this Appendix.

D.1 Mitretek Spreadsheet Model

A spreadsheet model was developed using Microsoft Excel to quickly analyze the impact of changes to the PCAPP parameters and operating scenarios. Two sets of models were developed; one for two-line processing and another for three line processing. Within each set, different operating scenarios were developed; the processing of rejects and leakers following the completion of each munition type (the original situation), the processing of rejects and leakers following the completion of all munition types, and the processing of only one type of munition at any given time.

The models simulate the entire processing life-cycle of the plant, starting at the shakedown and ramp-up phase through to the processing of the last munition. Numerous parameters can be modified in order to analyze the impact of proposed processes (see Table D-1 below). Based on these parameters, in addition to hard-coded logic, the models will assign the processing of munitions to the appropriate line in order to obtain the shortest processing duration.

The spreadsheet model is a static representation of the plant and does not include statistical variability. As such, the results are constantly available and the user is not required to 'run' the model. The model results include the total time to complete the operations campaign, as well as the amount of time processing and number and type of munitions processed during each phase on each line. In addition to the tabular output, the model also provides a chart showing the duration of each phase for each line.

The current set of models allows parameter variation to examine what are the current issues of concern. In the event that a quick analysis of a new operating scenario is needed, the current models can be readily modified to perform the work. Additional changes could also be implemented to transform some of the fixed parameters (i.e., switchovers are set at [redacted]) into user-changeable parameters. Also, global parameters (i.e., the reject processing rate is applied globally to all munition types) can be modified to allow unique values for each munition type.

Table D-1 – Spreadsheet Model Parameters

Variable	Description
Number of Munitions	The total number of munitions (by munition type)
Number of Leakers	The number of leakers (by munition type)
Number of Rejects	The number of Rejects (by munition type)
Normal Processing Rate	The processing rate based on the throughput of the PMD (the rate limiting step) during normal operations (by munition type)
Shakedown/Ramp-up Factor	The average percentage of the normal processing rate expected during the Shakedown/Ramp-up phase (by munition type)
Performance Testing Factor	The average percentage of the normal processing rate expected

Variable	Description
	during the Performance Testing phase (by munition type)
Post Pilot Processing Factor	The percentage of the normal processing rate expected during the Post Pilot Processing phase (by munition type)
Operations Factor	The percentage of the normal processing rate expected during the Operations phase (by munition type)
Reject Processing Rate	The rate at which rejects will be processed
Liquid Leaker Processing Rate	The rate at which liquid leakers will be processed
Vapor Leaker Processing factor	The percentage of the normal processing rate expected for processing vapor leakers.
Plant Capacity Factor	The combined equipment availability (assumed to be the product of the availabilities of the coupled rate limiting systems). Expressed as a percentage of the normal processing rate (by phase).
Other Factors	The percentage of the normal processing rate expected due to reduced availability caused by external and plant-wide factors, (Pre-operations and Post-operations)
Duration of phases	The duration (in weeks) of each pre-operations phase. (by phase)
Duration of reject/leaker switchover	The time required for tooling a line to process leakers and rejects. This is only required once per line

D.2 iGrafx Model Information

D.2.1 PCAPP Model Developed by BPT

BPT developed a simulation model of the PCAPP process using the discrete event simulation software iGrafx® Process 2003 from Corel. The software is designed to model and analyze business, manufacturing, or transactional processes. Models built in iGrafx can examine system and resource behavior and allow the testing of potential changes before they are implemented. A simple type of animation is available that uses colors to indicate various processing states of the systems during a model run. This trace mode runs significantly slower than normal run mode. More information about iGrafx can be found at www.igrafx.com.

BPT used results from its iGrafx model to calculate a predicted overall duration for the operations campaigns. The model was also reportedly used during the early PCAPP design efforts to help determine the numbers of each type of unit (or numbers of lines) needed in the facility. The model was developed using information from the PCAPP SOW along with engineering design information from the initial and intermediate design submittals (including process system design descriptions and material balances), system testing in the TRRP, and other sources. BPT reportedly performed some V&V activities on the iGrafx model after it was developed. Model basics are described in the TAA.

Each system or major piece of processing equipment in PCAPP is modeled and processes munitions, components, or agent, according to a specified processing rate or cycle time. The ETS is modeled at a simplified level (source of failures and downtime only) because the ETS is being redesigned. There is no transport time between processing equipment. It is also assumed that when the model needs a munition in the unpack area, it is available (ignores potential transport issues) Wood is the only dunnage processed through the facility model. The processing of secondary waste through the facility or MPTs is not modeled. The model is planned to be enhanced in some of these areas in support of the final design submittal.

All operations phases are modeled: shakedown/ramp-up, performance testing, post-pilot testing, and full rate operations. All munitions in the stockpile are allowed to process with concurrent processing of 155-mm projectiles, 105-mm projectiles, and 4.2-inch mortars being processed at the same time on each of the three lines. A [redacted] tooling switchover is assumed between munitions types. The numbers/percentages of leakers and rejects expected by BPT are shown in the TAA.

Normal processing rates from the TAA are used and adjusted by specified ramp-up percentages. These percentages are obtained from the original (1992) PCAPP Pilot Testing & Operations Summary spreadsheet table. Ramp-up increases from [redacted] of Normal rate in the [redacted] week of agent processing up to [redacted] of Normal rate (which equals the Peak rate) during the [redacted] week. Every other week during ramp-up is assumed have [redacted] throughput while the previous week's operations are reviewed and modifications are made to systems, equipment, operations procedures, etc., as needed. Processing rates are reduced for munitions that are characterized as leakers or rejects.

According to a set of parameters defining a statistical distribution, each system is randomly and independently allowed to go down and stop processing due to either an unscheduled failure or a scheduled maintenance activity. The systems are then repaired/maintained for a random time period calculated from specified parameters. Normal distributions are assumed for all parameters with the iGrafx *BetweenNorm* function used to allow the specification of minimum and maximum values at 3-sigma (standard deviation) limits. Downtimes on a system will stop processing at upstream systems through hard stops implemented in the model to prevent inadvertent surges in the model. For example, before a munition is process at the PMD, the model will check to make sure the ETS, ERH, or HDC (or PMD) is not down before processing. Any failure or downtime shuts down all PMDs for the entire duration. Partially dependent on future safety reviews, continued processing may occur in other ECRs during some or all of this time. Thus, the system modeling is conservative.

When the model runs, a munition or component entering a system will trigger a check to determine if it has arrived at a time after the system is supposed to go down for failure or maintenance. If so, the system is taken out of service for the specified time duration and a new failure/downtime time is calculated. The time based failures/downtimes are thus partially cycle based since they require an entry event to trigger them. This underestimates the total numbers of events required because some are delayed when a system is idle or blocked. On the other hand, all maintenance events now have an adverse affect on production, while if the downtimes were strictly time based, some would occur and be resolved during idle times with no affect on throughput.

If a maintenance event occurs, the next failure event is reset to occur later in time because it is assumed that maintenance is beneficial to the system performance. This results in less failures occurring than what is specified (parameters determined based on engineering judgment and data) for each system.

The model assumes that HDC maintenance activities are performed concurrently along with ERH maintenance; however, the frequency has not been increased nor has the maintenance time been increased. The MWS does not use the online spare CAM, thus the model is conservative. When any CAM fails (or is maintained), the MWS is down in the model, while in the plant, two CAMs need to fail before the MWS is down. On the other hand, the [redacted] availability specified in the TAA apparently refers to the MWS as a system; thus the MWS with 4 operating CAMs does not fail twice as often as the MWS with 2 operating CAMs. ICBs are assumed to be available when needed (no maintenance or repair is currently modeled).

Physical buffer areas, such as buffers for trays of projectiles before the MWSs or MPTs are not explicitly modeled. Instead, items in the queue (or surge) between systems can be monitored. A major limitation of the software is the difficulty in collecting buffer area capacity statistics during a run. In order to examine the utilization or capacity of a buffer area, the contents must be written to an on-screen graph and the model must be run in its slower trace animation mode (which precludes its widespread use). After the run is completed, the graph can be examined and pasted as a picture to other software, but access to the data is not possible. Global variables have recently been added to the model to monitor and track maximum capacity in various buffer areas (and between all systems). These variables can be examined after a run by reviewing custom statistics.

D.2.2 Mitretek Revisions to PCAPP Model

Mitretek did not perform a formal verification and validation (V&V) on the model to determine the validity of its results, nor did Mitretek have a copy of the model code to examine. However, a Mitretek staff member spent a couple of days in Pueblo, CO with one of the model developers. The developer demonstrated the operation of the model and presented and explained the model input parameters and outputs. Onsite discussions and follow-up phone calls revealed a few, mostly minor, problems with the model. The model was then modified to correct the problems and to add enhancements to allow better use of model output statistics. Most or all of the modifications and enhancements were intended to be incorporated into an updated base model that would be used for the final design submittal.

The model developer then made changes to the BPT base model to reflect the Mitretek cases presented in this study. Most cases involved minor modifications such as the changing of model input parameters relating to reliability parameters or the numbers of rejects. Other changes required more substantial changes to the code such as the moving of the processing of leakers and rejects to after all of the normal campaigns. The creation of a 2-line model from the 3-line case was not trivial, although BPT had done a similar modification in previous analysis of alternatives efforts. Mitretek again reviewed model outputs to confirm whether throughputs, numbers of failures/downtimes, availabilities, and other results were as expected.

The reliability parameters used in the Mitretek cases are shown in Table D-2 on page 160 for the 3-line cases (base and modified/pessimistic) and in Table D-3 on page 161 for the 2-line cases (base and modified/pessimistic). As discussed in §3.1.2.2 on page 59, Mitretek used the values in the TAA as starting points and changed them based on historical data and engineering judgment. Maintenance/Repair Duration times include mean repair/maintenance time plus start-up and shut-down time specified in the TAA. The BetweenNorm distribution is used in iGrafx for the Normal distribution which sets the minimum and maximum values at 3 sigma (standard deviation) limits. The model does not currently include ICB maintenance or repair events; the ICB is generally decoupled and it not expected to be a bottleneck.

For the pessimistic data set, the most-likely parameters were modified by increasing the failure/maintenance frequencies (actually decreasing times between failures) and/or increasing the repair/maintenance times, resulting in lowered availabilities for systems. All values are estimates and there is significant uncertainty because most of the systems have not been demonstrated for the PCAPP scale or length of service or in the PCAPP application.

The TAA provided parameters for the HDC and ERH, but did not appear to consider major support equipment (ERH/HDC transfer conveyor, ERH Inlet Module, and ERH Hydrolysate Bag Filter) parameters provided in the calculation document 24852-M4C-000-B0004. Mitretek's HDC system parameters include additional maintenance/repair time for the ERH/HDC transfer conveyor and the ERH system parameters include additional maintenance/repair time for the ERH Inlet Module and the ERH Hydrolysate Bag Filter.

Table D-2 – Model Input Parameters for 3-Line Cases

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Table D-3 – Model Input Parameters for 2-Line Cases

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Appendix E Staffing Evaluation

The following tables represent a line-by-line comparative PCAPP staffing analysis between the IGCE and Mitretek staffing estimates.

E.1 Mitretek versus IGCE – 3-Line Base Case

The following tables represent a line by line comparative PCAPP overall peak staffing analysis between the IGCE staffing estimate and the Mitretek proposed 3-line process.

Table E-1 – Project Services 3-Line Staffing Comparison

IGCE (from App. C-1, 5-28-04 Rev. 1)		Mitretek 3-Line Estimate	
Position Description	**Ops**	**Position Description**	**Ops**
Project Management	[redacted]	**Project Management**	[redacted]
Project Manager	[redacted]	Project Manager	[redacted]
Assistant Project Manager	[redacted]	Assistant Project Manager	[redacted]
	[redacted]		[redacted]
Director of Contracts	[redacted]	Director of Contracts	[redacted]
Human Resources Manager	[redacted]	Human Resources Manager	[redacted]
Environmental & Safety Manager	[redacted]	Environmental & Safety Manager	[redacted]
Plant Manager	[redacted]	Plant Manager	[redacted]
	[redacted]	Assistant Plant Manager	[redacted]
Systemization Manager	[redacted]	Systemization Manager	[redacted]
Parsons Project Manager	[redacted]	Parsons Project Manager	[redacted]
WDC Project Manager	[redacted]	WDC Project Manager	[redacted]
Battelle Project Manager	[redacted]	Battelle Project Manager	[redacted]
Closure Manager	[redacted]	Closure Manager	[redacted]
Six Sigma (Process Improvement)	[redacted]	Six Sigma (Process Improvement)	[redacted]
Public Involvement & Outreach Manager	[redacted]	Public Involvement & Outreach Manager	[redacted]
	[redacted]		[redacted]
Public Outreach Coordinators	[redacted]	Public Outreach Coordinators	[redacted]
Project Management Totals	[redacted]	**Project Management Totals**	[redacted]
Business Management	[redacted]	**Business Management**	[redacted]
Business Manager	[redacted]	Business Manager	[redacted]
	[redacted]		[redacted]
Controller	[redacted]	Controller	[redacted]
	[redacted]	Controller rep (BNI)	[redacted]
Contracts / Accounting	[redacted]	Contracts / Accounting	[redacted]
Prime Contracts Manager	[redacted]	Prime Contracts Manager	[redacted]
Prime Contracts Admin / Accounting	[redacted]	Prime Contracts Admin / Accounting	[redacted]
	[redacted]	Payroll	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Purchasing	[redacted]	Purchasing	[redacted]
Acquisition Manager	[redacted]	Acquisition Manager	[redacted]
Purchasing Agents / Expeditors	[redacted]	Purchasing Agents / Expeditors	[redacted]
Subcontract Administrators	[redacted]	Subcontract Administrators	[redacted]
Property Database Management	[redacted]	Property Database Management	[redacted]
BPS Coordinator	[redacted]	BPS Coordinator	[redacted]
Supplier Advocate	[redacted]	Supplier Advocate	[redacted]

17 The [redacted] is only included during the systemization phase, not during the operations phase as described in this table.

Subcontract Administrator - Teaming Partners	[redacted]	Subcontract Administrator - Teaming Partners	[redacted]
Project Controls	[redacted]	Project Controls	[redacted]
Project Controls Manager	[redacted]	Project Controls Manager	[redacted]
	[redacted]	Project Controls Specialist	[redacted]
	[redacted]		[redacted]
Project Controls Supervisor	[redacted]		[redacted]
Estimating Supervisor	[redacted]	Estimating Supervisor	[redacted]
Schedule Supervisor	[redacted]	Schedule Supervisor	[redacted]
SOURCE Administrator	[redacted]	SOURCE Administrator	[redacted]
EVMS Administrator	[redacted]	EVMS Administrator	[redacted]
Schedulers	[redacted]	Schedulers	[redacted]
	[redacted]		[redacted]
Cost Engineers	[redacted]	Cost Engineers	[redacted]
	[redacted]		[redacted]
Funds/Financial Analyst	[redacted]	Funds/Financial Analyst	[redacted]
	[redacted]		[redacted]
Science & Technology	[redacted]	Science & Technology	[redacted]
Chief Scientist	[redacted]	Chief Scientist	[redacted]
Scientists	[redacted]	Scientists	[redacted]
	[redacted]		[redacted]
Business Management Totals	[redacted]	**Business Management Totals**	[redacted]
Services Management	[redacted]	**Services Management**	[redacted]
Services Manager	[redacted]	Services Manager	[redacted]
	[redacted]	Closure engineering support	[redacted]
Human resources	[redacted]	Human resources	[redacted]
Human Resources Asst Coordinator	[redacted]	Human Resources Asst Coordinator	[redacted]
Human Resources Specialist	[redacted]	Human Resources Specialist	[redacted]
	[redacted]	HR rep	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Surety / Security	[redacted]	Surety / Security	[redacted]
Surety & Security Manager	[redacted]	Surety & Security Manager	[redacted]
Clearance Coordinators	[redacted]	Surety rep/Clearance coordinators	[redacted]
Security Officer	[redacted]	Security Officer ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
ES & H	[redacted]	ES & H	[redacted]
Safety & Health Specialist	[redacted]	Safety & Health Specialist ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
QA / QC	[redacted]	QA / QC	[redacted]
	[redacted]	Lab QA/QC Manager	[redacted]
Quality Manager	[redacted]	QA/QC Manager	[redacted]
	[redacted]	Lab QA / QC Specialist ([redacted] per shift)	[redacted]
	[redacted]	Plant QC Engineers	[redacted]
	[redacted]	Plant QA inspector	[redacted]
	[redacted]	QA/QC supervisor	[redacted]
QA / QC Engineers	[redacted]	QA/QC Engineers	[redacted]
	[redacted]		[redacted]
Emergency Response	[redacted]	Emergency Response	[redacted]
	[redacted]	EP manager	[redacted]
Emergency Management	[redacted]	Emergency response specialist	[redacted]
	[redacted]	EP planner/trainer	[redacted]
IS & T	[redacted]	IS & T	[redacted]
Information Systems & Technology Manager	[redacted]	Information Systems & Technology Manager	[redacted]
Information Systems & Technology Asst Manager	[redacted]	Information Systems & Technology Asst	[redacted]
Automation Support Analyst	[redacted]	Automation Support Analyst	[redacted]
Programming Analyst	[redacted]	Programming Analyst	[redacted]
Desktop Support	[redacted]	Desktop Support	[redacted]
	[redacted]		[redacted]
Environmental Compliance	[redacted]	Environmental Compliance	[redacted]
Environmental Manager (HO)	[redacted]	Environmental Manager (HO)	[redacted]
Environmental Specialist Sr. (Field)	[redacted]	Environmental Specialist Sr. (Field)	[redacted]
Environmental Specialist Sr. (HO)	[redacted]	Environmental Specialist Sr. (HO)	[redacted]
Environmental Specialist (Field)	[redacted]	Environmental Specialist (Field)	[redacted]

Environmental Specialist (HO)	[redacted]	Environmental Specialist (HO)	[redacted]
Environmental Specialist - Compliance (Field)	[redacted]	Environmental Specialist - Compliance (Field)	[redacted]
Environmental Specialist - Compliance (HO)	[redacted]	Environmental Specialist - Compliance (HO)	[redacted]
Environmental Permitting	[redacted]	Environmental Permitting	[redacted]
	[redacted]		[redacted]
Environmental Specialist, Sr. (Field)	[redacted]	Environmental Specialist, Sr. (Field)	[redacted]
Environmental Specialist (Field)	[redacted]	Environmental Specialist (Field)	[redacted]
Project Admin. Environmental (Field)	[redacted]	Project Admin. Environmental (Field)	[redacted]
Training	[redacted]	Training	[redacted]
	[redacted]		[redacted]
Training Coordinator / Records	[redacted]	Training Coordinator / Records	[redacted]
Training Specialist	[redacted]	Training Specialist	[redacted]
Training Admin Asst	[redacted]	Training Admin Asst	[redacted]
Education Specialist	[redacted]	Education Specialist	[redacted]
Medical	[redacted]	Medical	[redacted]
Medical Director	[redacted]	Medical Director	[redacted]
Nurses and Med Technicians	[redacted]	Nurse and ed Technicians	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Warehouse	[redacted]	Warehouse	[redacted]
Warehouse Manager	[redacted]	Warehouse Manager	[redacted]
Warehouse Supervisor	[redacted]	Warehouse Supervisor ([redacted] per shift)	[redacted]
Warehouse Personnel	[redacted]	Warehouse Personnel ([redacted] per shift)	[redacted]
	[redacted]	Warehouse - Receiving	[redacted]
	[redacted]	Property inventory specialist	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Waste Management	[redacted]	Waste Management	[redacted]
Waste Management Manager	[redacted]	Waste Management Manager	[redacted]
Waste Coordinator	[redacted]	Waste coordinator /handler	[redacted]
	[redacted]	Waste shipper/planner ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
Configuration Management / O&AS	[redacted]	Configuration Management / Engineering	[redacted]
HO Configuration Mgmt	[redacted]	HO Configuration Mgmt	[redacted]
Site Configuration Mgmt	[redacted]	Site Configuration Mgmt	[redacted]
	[redacted]		[redacted]
	[redacted]	Note: all other engineering functions placed	[redacted]
	[redacted]		[redacted]
Admin support	[redacted]	Admin support	[redacted]
	[redacted]	Admin Asst - acquisitions	[redacted]
Admin Asst. Business Services	[redacted]	Admin Asst - bus mgt	[redacted]
Admin Asst. Human Resources	[redacted]	Admin Asst – HR	[redacted]
	[redacted]	Admin Asst -Contracts & Procurement	[redacted]
	[redacted]	Admin Asst - public outreach	[redacted]
Admin Asst. Services	[redacted]	Admin asst - services	[redacted]
	[redacted]		[redacted]
Document Control Clerk	[redacted]	Document control clerk ([redacted] per shift)	[redacted]
Facilities / Office Services	[redacted]		[redacted]
Administrative Support	[redacted]	Administrative Support ([redacted] per shift)	[redacted]
Secretary - Management	[redacted]	Secretary - Management	[redacted]
Receptionist	[redacted]	Receptionist	[redacted]
Admin Support / Document Control	[redacted]		[redacted]
	[redacted]	Admin Support – Security & Surety	[redacted]
Clerk	[redacted]		[redacted]
	[redacted]		[redacted]
Janitorial staff moved to plant staff ([redacted] slots)	[redacted]		[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Services Management Totals	[redacted]	**Services Management Totals**	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Project Services Totals without Fee	[redacted]	**Project Services Totals**	[redacted]

Table E-2 – Plant Staff 3-Line Staffing Comparison

IGCE		Mitretek 3-line Process	
	FY10		FY10
Position Description	**oct**	**Position Description**	**oct**
Agent Chemist	[redacted]	Agent Chemist	[redacted]
Agent tech	[redacted]	Agent tech	[redacted]
analytical branch manager	[redacted]	analytical branch manager	[redacted]
area supervisor	[redacted]	area supervisor	[redacted]
assist maintenance manager	[redacted]	assist maintenance manager	[redacted]
assist ops manager	[redacted]	assist ops manager	[redacted]
carpenter	[redacted]	carpenter	[redacted]
Chemical Technician	[redacted]	Chemical Technician	[redacted]
Chemical Technician	[redacted]	Chemical Technician	[redacted]
control room operator	[redacted]	control room operator ([redacted] positions/shift)	[redacted]
control room supervisor	[redacted]	control room supervisor	[redacted]
control room supervisors	[redacted]	control room supervisors	[redacted]
DAAMS tech (reduced [redacted] to [redacted])	[redacted]	DAAMS tech ([redacted] per shift)	[redacted]
Drafter/Technician	[redacted]	Drafter/Technician	[redacted]
Electrician (reduced [redacted] to [redacted])	[redacted]	Electrician ([redacted] per shift)	[redacted]
GC/FPD/MSD Operator(reduced [redacted] to [redacted])	[redacted]	GC/FPD/MSD Operator ([redacted] per shift)	[redacted]
GC/MSD operator	[redacted]	GC/MSD operator	[redacted]
GC/MSD operator	[redacted]	GC/MSD operator	[redacted]
GC/MSD P&T operator	[redacted]	GC/MSD P&T operator	[redacted]
Hazardous Waste Tech	[redacted]	Hazardous Waste Tech	[redacted]
HPLC Operator	[redacted]	HPLC Operator	[redacted]
HPLC Operator	[redacted]	HPLC Operator	[redacted]
I&E lead	[redacted]	I&E lead	[redacted]
ICP-MS operator	[redacted]	ICP-MS operator	[redacted]
instrument tech(reduced [redacted] to [redacted])	[redacted]	instrument tech ([redacted] per shift)	[redacted]
Janitorial	[redacted]	Janitorial	[redacted]
Lab Manager	[redacted]	Lab Manager	[redacted]
laborers	[redacted]	laborers	[redacted]
maintenance engineers	[redacted]	Maintenance engineers	[redacted]
maintenance manager	[redacted]	Maintenance manager	[redacted]
material coordinator	[redacted]	material coordinator	[redacted]
Mechanical Lead	[redacted]	Mechanical Lead	[redacted]
mechanics (reduced [redacted] to [redacted])	[redacted]	mechanics ([redacted] per shift)	[redacted]
MINICAMS tech	[redacted]	MINICAMS tech	[redacted]
monitoring branch manager	[redacted]	monitoring branch manager	[redacted]
monitoring branch shift leader	[redacted]	monitoring branch shift leader	[redacted]
Monitoring instrument tech(reduced [redacted] to [redacted])	[redacted]	Monitoring instrument tech ([redacted] per shift)	[redacted]
Operations branch manager	[redacted]	Operations branch manager	[redacted]
operations branch shift leader	[redacted]	operations branch shift leader	[redacted]
operations manager	[redacted]		[redacted]
operations support manager	[redacted]	operations support manager	[redacted]
ORR/Control Operations	[redacted]	ORR/Control Operations	[redacted]
outside area operator (reduced [redacted] to [redacted])	[redacted]	outside area operator (reduced [redacted] to [redacted])	[redacted]
outside area supervisor	[redacted]	outside area supervisor	[redacted]
painter	[redacted]	painter	[redacted]
PMB supervisor	[redacted]	PMB supervisor	[redacted]
PPE specialist	[redacted]	PPE specialist	[redacted]
production control manager	[redacted]	production control manager	[redacted]
production specialist	[redacted]	production specialist	[redacted]
production specialist	[redacted]	production specialist	[redacted]
programmer	[redacted]	programmer	[redacted]
Resident Engineer	[redacted]	Resident Engineer	[redacted]
sampling tech	[redacted]	sampling tech	[redacted]

18 The [redacted] [redacted] [redacted] [redacted] and is not present during the operations phase as described in this table.

IGCE		Mitretek 3-line Process	
	FY10		FY10
Scientists	[redacted]	Scientists	[redacted]
Senior Design Engineer	[redacted]	Senior Design Engineer	[redacted]
Senior Discipline Engineer	[redacted]	Senior Discipline Engineer	[redacted]
	[redacted]	Systems Engineer ([redacted] per shift)	[redacted]
	[redacted]	Automation Engineer ([redacted] per shift)	[redacted]
shift maintenance engineer	[redacted]	shift maintenance engineer	[redacted]
shift manager	[redacted]	shift manager (for Plant Operations)	[redacted]
shift manager	[redacted]		[redacted]
shift supervisor	[redacted]	shift supervisor	[redacted]
statistician	[redacted]	statistician	[redacted]
Tech Specialists	[redacted]		[redacted]
TRAC data coordinator	[redacted]	TRAC data coordinator	[redacted]
TRAC specialist	[redacted]	TRAC specialist	[redacted]
Utility Lead	[redacted]	Utility Lead	[redacted]
Welders	[redacted]	Welders	[redacted]
work control	[redacted]	work control	[redacted]
work planners	[redacted]	work planners	[redacted]
work planning supervisor	[redacted]	work planning supervisor	[redacted]
work scheduler	[redacted]	work scheduler	[redacted]
Plant Services Total	[redacted]	**Plant Services Total**	[redacted]

E.2 Mitretek 3-Line Base Case versus 2-Line Alternative

The following tables represent a line by line comparative PCAPP overall peak staffing analysis between the Mitretek proposed 3-line process and the alternative Mitretek 2-line process.

Table E-3 – Mitretek 3-Line versus Mitretek 2-Line Comparative Analysis: Project Services

Mitretek 3-Line Estimate		Mitretek 2-Line Estimate	
Position Description	Ops	Position Description	Ops
Project Management	[redacted]	**Project Management**	[redacted]
Project Manager	[redacted]	Project Manager	[redacted]
Assistant Project Manager	[redacted]	Assistant Project Manager	[redacted]
	[redacted]		[redacted]
Director of Contracts	[redacted]	Director of Contracts	[redacted]
Human Resources Manager	[redacted]	Human Resources Manager	[redacted]
Environmental & Safety Manager	[redacted]	Environmental & Safety Manager	[redacted]
Plant Manager	[redacted]	Plant Manager	[redacted]
Assistant Plant Manager	[redacted]	Assistant Plant Manager	[redacted]
Systemization Manager	[redacted]	Systemization Manager	[redacted]
Parsons Project Manager	[redacted]	Parsons Project Manager	[redacted]
WDC Project Manager	[redacted]	WDC Project Manager	[redacted]
Battelle Project Manager	[redacted]	Battelle Project Manager	[redacted]
Closure Manager	[redacted]	Closure Manager	[redacted]
Six Sigma (Process Improvement)	[redacted]	Six Sigma (Process Improvement)	[redacted]
Public Involvement & Outreach Manager	[redacted]	Public Involvement & Outreach Manager	[redacted]
	[redacted]		[redacted]
Public Outreach Coordinators	[redacted]	Public Outreach Coordinators	[redacted]
Project Management Totals	[redacted]	**Project Management Totals**	[redacted]
Business Management	[redacted]	**Business Management**	[redacted]
Business Manager	[redacted]	Business Manager	[redacted]

19 The [redacted] [redacted] [redacted], [redacted] not during the operations phase as described in this table.

Mitretek 3-Line Estimate Position Description	Ops	Mitretek 2-Line Estimate Position Description	Ops
	[redacted]		[redacted]
Controller	[redacted]	Controller	[redacted]
Controller rep (BNI)	[redacted]	Controller rep (BNI)	[redacted]
Contracts / Accounting	[redacted]	Contracts / Accounting	[redacted]
Prime Contracts Manager	[redacted]	Prime Contracts Manager	[redacted]
Prime Contracts Admin / Accounting	[redacted]	Prime Contracts Admin / Accounting	[redacted]
Payroll	[redacted]	Payroll	[redacted]
	[redacted]		[redacted]
Purchasing	[redacted]	Purchasing	[redacted]
Acquisition Manager	[redacted]	Acquisition Manager	[redacted]
Purchasing Agents / Expeditors	[redacted]	Purchasing Agents / Expeditors	[redacted]
Subcontract Administrators	[redacted]	Subcontract Administrators	[redacted]
Property Database Management	[redacted]	Property Database Management	[redacted]
BPS Coordinator	[redacted]	BPS Coordinator	[redacted]
Supplier Advocate	[redacted]	Supplier Advocate	[redacted]
Subcontract Administrator - Teaming Partners	[redacted]	Subcontract Administrator - Teaming Partners	[redacted]
Project Controls	[redacted]	Project Controls	[redacted]
Project Controls Manager	[redacted]	Project Controls Manager	[redacted]
Project Controls Specialist	[redacted]	Project Controls Specialist	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Estimating Supervisor	[redacted]	Estimating Supervisor	[redacted]
Schedule Supervisor	[redacted]	Schedule Supervisor	[redacted]
SOURCE Administrator	[redacted]	SOURCE Administrator	[redacted]
EVMS Administrator	[redacted]	EVMS Administrator	[redacted]
Schedulers	[redacted]	Schedulers	[redacted]
	[redacted]		[redacted]
Cost Engineers	[redacted]	Cost Engineers	[redacted]
	[redacted]		[redacted]
Funds/Financial Analyst	[redacted]	Funds/Financial Analyst	[redacted]
	[redacted]		[redacted]
Science & Technology	[redacted]	Science & Technology	[redacted]
Chief Scientist	[redacted]	Chief Scientist	[redacted]
Scientists	[redacted]	Scientists	[redacted]
	[redacted]		[redacted]
Business Management Totals	[redacted]	**Business Management Totals**	[redacted]
Services Management	[redacted]	**Services Management**	[redacted]
Services Manager	[redacted]	Services Manager	[redacted]
Closure engineering support	[redacted]	Closure engineering support	[redacted]
Human resources	[redacted]	Human resources	[redacted]
Human Resources Asst Coordinator	[redacted]	Human Resources Asst Coordinator	[redacted]
Human Resources Specialist	[redacted]	Human Resources Specialist	[redacted]
HR rep	[redacted]	HR rep	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Surety / Security	[redacted]	Surety / Security	[redacted]
Surety & Security Manager	[redacted]	Surety & Security Manager	[redacted]
Surety rep/Clearance coordinators	[redacted]	Surety rep/Clearance coordinators	[redacted]
Security Officer ([redacted] per shift)	[redacted]	Security Officer ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
ES & H	[redacted]	ES & H	[redacted]
Safety & Health Specialist ([redacted] per shift)	[redacted]	Safety & Health Specialist ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
QA / QC	[redacted]	QA / QC	[redacted]
Lab QA/QC Manager	[redacted]	Lab QA/QC Manager	[redacted]
QA/QC Manager	[redacted]	Quality Manager (QA/QC)	[redacted]
Lab QA / QC Specialist ([redacted] per shift)	[redacted]	Lab QA / QC Specialist ([redacted] per shift)	[redacted]
Plant QC Engineers	[redacted]	Plant QC Engineers	[redacted]
Plant QA inspector	[redacted]	Plant QA inspector	[redacted]
QA/QC supervisor	[redacted]	QA/QC supervisor	[redacted]

Mitretek 3-Line Estimate Position Description	Ops	Mitretek 2-Line Estimate Position Description	Ops
QA/QC Engineers	[redacted]	QA/QC Engineers	[redacted]
	[redacted]		[redacted]
Emergency Response	[redacted]	Emergency Response	[redacted]
EP manager	[redacted]	EP manager	[redacted]
Emergency response specialist	[redacted]	Emergency response specialist	[redacted]
EP planner/trainer	[redacted]	EP planner/trainer	[redacted]
IS & T	[redacted]	IS & T	[redacted]
Information Systems & Technology Manager	[redacted]	Information Systems & Technology Manager	[redacted]
Information Systems & Technology Asst Manager	[redacted]	Information Systems & Technology Asst Manager	[redacted]
Automation Support Analyst	[redacted]	Automation Support Analyst	[redacted]
Desktop Support	[redacted]	Desktop Support	[redacted]
	[redacted]		[redacted]
Environmental Compliance	[redacted]	Environmental Compliance	[redacted]
Environmental Manager (HO)	[redacted]	Environmental Manager (HO)	[redacted]
Environmental Specialist Sr. (Field)	[redacted]	Environmental Specialist Sr. (Field)	[redacted]
Environmental Specialist Sr. (HO)	[redacted]	Environmental Specialist Sr. (HO)	[redacted]
Environmental Specialist (Field)	[redacted]	Environmental Specialist (Field)	[redacted]
Environmental Specialist (HO)	[redacted]	Environmental Specialist (HO)	[redacted]
Environmental Specialist - Compliance (Field)	[redacted]	Environmental Specialist - Compliance (Field)	[redacted]
Environmental Specialist - Compliance (HO)	[redacted]	Environmental Specialist - Compliance (HO)	[redacted]
Environmental Permitting	[redacted]	Environmental Permitting	[redacted]
	[redacted]		[redacted]
Environmental Specialist, Sr. (Field)	[redacted]	Environmental Specialist, Sr. (Field)	[redacted]
Environmental Specialist (Field)	[redacted]	Environmental Specialist (Field)	[redacted]
Project Admin. Environmental (Field)	[redacted]	Project Admin. Environmental (Field)	[redacted]
Training	[redacted]	Training	[redacted]
	[redacted]		[redacted]
Training Coordinator / Records	[redacted]	Training Coordinator / Records	[redacted]
Training Specialist	[redacted]	Training Specialist	[redacted]
Training Admin Asst	[redacted]	Training Admin Asst	[redacted]
Education Specialist	[redacted]	Education Specialist	[redacted]
Medical	[redacted]	Medical	[redacted]
Medical Director	[redacted]	Medical Director	[redacted]
Nurse and ed Technicians	[redacted]	Nurse ([redacted] per shift)	[redacted]
	[redacted]	EMTs ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
Warehouse	[redacted]	Warehouse	[redacted]
Warehouse Manager	[redacted]	Warehouse Manager	[redacted]
Warehouse Supervisor ([redacted] per shift)	[redacted]	Warehouse Supervisor ([redacted] per shift)	[redacted]
Warehouse Personnel ([redacted] per shift)	[redacted]	Warehouse Personnel ([redacted] per shift)	[redacted]
Warehouse - Receiving	[redacted]	Warehouse - Receiving	[redacted]
Property inventory specialist	[redacted]	Property inventory specialist	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Waste Management	[redacted]	Waste Management	[redacted]
Waste Management Manager	[redacted]	Waste Management Manager	[redacted]
Waste coordinator /handler	[redacted]	Waste handler	[redacted]
Waste shipper/planner ([redacted] per shift)	[redacted]	Waste shipper/planner ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
Configuration Management / Engineering	[redacted]	Configuration Management / Engineering	[redacted]
HO Configuration Mgmt	[redacted]	Configuration manager	[redacted]
Site Configuration Mgmt	[redacted]	Configuration management specialist	[redacted]
	[redacted]		[redacted]
Note: all other engineering functions placed under	[redacted]	Note: all other engineering functions placed under	[redacted]
	[redacted]		[redacted]
Admin support	[redacted]	Admin support	[redacted]
Admin Asst - acquisitions	[redacted]	Admin Asst - acquisitions	[redacted]
Admin Asst - bus mgt	[redacted]	Admin Asst - bus mgt	[redacted]
Admin Asst - HR	[redacted]	Admin Asst - HR	[redacted]
Admin Asst -Contracts & Procurement	[redacted]	Admin Asst -Contracts & Procurement	[redacted]
Admin Asst - public outreach	[redacted]	Admin Asst - public outreach	[redacted]

Mitretek 3-Line Estimate		Mitretek 2-Line Estimate	
Position Description	**Ops**	**Position Description**	**Ops**
Admin asst - services	[redacted]	Admin asst - services	[redacted]
	[redacted]		[redacted]
Document control clerk ([redacted] per shift)	[redacted]	Document control clerk ([redacted] per shift)	[redacted]
	[redacted]		[redacted]
Administrative Support ([redacted] per shift)	[redacted]	Administrative Support ([redacted] per shift)	[redacted]
Secretary - Management	[redacted]	Secretary – Project Management	[redacted]
Receptionist	[redacted]	Receptionist	[redacted]
	[redacted]		[redacted]
Admin Support - Security & Surety	[redacted]	Admin Support - Security & Surety	[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
	[redacted]		[redacted]
Services Management Totals	[redacted]	**Services Management Totals**	[redacted]
Project Services Totals	[redacted]	**Project Services Totals**	[redacted]

Table E-4 – Mitretek 3-Line versus Mitretek 2-Line Comparative Analysis: Plant Staff

Mitretek 3-line Process		Mitretek 2-line Process	
	Ops		**Ops**
Agent Chemist	[redacted]	Agent Chemist	[redacted]
Agent tech	[redacted]	Agent tech	[redacted]
analytical branch manager	[redacted]	analytical branch manager	[redacted]
area supervisor	[redacted]	area supervisor	[redacted]
assist maintenance manager	[redacted]	assist maintenance manager	[redacted]
assist ops manager	[redacted]	assist ops manager	[redacted]
Carpenter	[redacted]	Carpenter	[redacted]
Chemical Technician	[redacted]	Chemical Technician	[redacted]
Chemical Technician	[redacted]	Chemical Technician	[redacted]
control room operator ([redacted] positions/shift)	[redacted]	control room operator ([redacted] positions/shift)	[redacted]
control room supervisors	[redacted]	control room supervisors	[redacted]
DAAMS tech ([redacted] per shift)	[redacted]	DAAMS tech ([redacted] per shift)	[redacted]
Drafter/Technician	[redacted]	Drafter/Technician	[redacted]
Electrician ([redacted] per shift)	[redacted]	Electrician ([redacted] per shift)	[redacted]
GC/FPD/MSD Operator ([redacted] per shift)	[redacted]	GC/FPD/MSD Operator ([redacted] per shift)	[redacted]
GC/MSD operator	[redacted]	GC/MSD operator	[redacted]
GC/MSD operator	[redacted]	GC/MSD operator	[redacted]
GC/MSD P&T operator	[redacted]	GC/MSD P&T operator	[redacted]
Hazardous Waste Tech	[redacted]	Hazardous Waste Tech	[redacted]
HPLC Operator	[redacted]	HPLC Operator	[redacted]
HPLC Operator	[redacted]	HPLC Operator	[redacted]
I&E lead	[redacted]	I&E lead	[redacted]
ICP-MS operator	[redacted]	ICP-MS operator	[redacted]
instrument tech ([redacted] per shift)	[redacted]	instrument tech ([redacted] per shift)	[redacted]
Janitorial	[redacted]	Janitorial	[redacted]
Lab Manager	[redacted]	Lab Manager	[redacted]
Laborers	[redacted]	Laborers	[redacted]
maintenance engineers	[redacted]	Maintenance engineers	[redacted]
maintenance manager	[redacted]	Maintenance manager	[redacted]
material coordinator	[redacted]	material coordinator	[redacted]
Mechanical Lead	[redacted]	Mechanical Lead	[redacted]
mechanics ([redacted] per shift)	[redacted]	mechanics ([redacted] per shift)	[redacted]
MINICAMS tech	[redacted]	MINICAMS tech	[redacted]
monitoring branch manager	[redacted]	monitoring branch manager	[redacted]

Mitretek 3-line Process		Mitretek 2-line Process	
	Ops		Ops
monitoring branch shift leader	[redacted]	monitoring branch shift leader	[redacted]
Monitoring instrument tech ([redacted] per shift)	[redacted]	Monitoring instrument tech ([redacted] per shift)	[redacted]
Operations branch manager	[redacted]	Operations branch manager	[redacted]
operations branch shift leader	[redacted]	operations branch shift leader	[redacted]
operations support manager	[redacted]	operations support manager	[redacted]
ORR/Control Operations	[redacted]	ORR/Control Operations	[redacted]
outside area operator (reduced [redacted] to [redacted])	[redacted]	outside area operator (reduced [redacted] to [redacted])	[redacted]
outside area supervisor	[redacted]	outside area supervisor	[redacted]
painter	[redacted]	Painter	[redacted]
PMB supervisor	[redacted]	PMB supervisor	[redacted]
PPE specialist	[redacted]	PPE specialist	[redacted]
production control manager	[redacted]	production control manager	[redacted]
production specialist	[redacted]	production specialist	[redacted]
production specialist	[redacted]	production specialist	[redacted]
programmer	[redacted]	Programmer	[redacted]
Resident Engineer	[redacted]	Resident Engineer	[redacted]
sampling tech	[redacted]	sampling tech	[redacted]
Scientists	[redacted]	Scientists	[redacted]
Senior Design Engineer	[redacted]	Senior Design Engineer	[redacted]
Senior Discipline Engineer	[redacted]	Senior Discipline Engineer	[redacted]
Systems Engineer ([redacted] per shift)	[redacted]	Systems Engineer ([redacted] per shift)	[redacted]
Automation Engineer ([redacted] per shift)	[redacted]	Automation Engineer ([redacted] per shift)	[redacted]
Shift maintenance engineer	[redacted]	shift maintenance engineer	[redacted]
Shift manager (for Plant Operations)	[redacted]	shift manager (for Plant Operations)	[redacted]
Shift supervisor	[redacted]	shift supervisor	[redacted]
statistician	[redacted]	Statistician	[redacted]
	[redacted]		[redacted]
TRAC data coordinator	[redacted]	TRAC data coordinator	[redacted]
TRAC specialist	[redacted]	TRAC specialist	[redacted]
Utility Lead	[redacted]	Utility Lead	[redacted]
Welders	[redacted]	Welders	[redacted]
Work control	[redacted]	work control	[redacted]
Work planners	[redacted]	work planners	[redacted]
Work planning supervisor	[redacted]	work planning supervisor	[redacted]
Work scheduler	[redacted]	work scheduler	[redacted]
Plant Services Total	[redacted]	**Plant Services Total**	[redacted]

[20] The [redacted] and is not present during the operations phase as described in this table.

Appendix F Cost Evaluation

The spreadsheets used in the cost analysis are listed below and can be found electronically on the CD-ROM included as Enclosure 1.

F.1 Cost Spreadsheets for 3-Line 'Base Case'

This section of the appendix lists the outputs and supporting cost input spreadsheets for Mitretek's 3-line "base case," which can be found electronically in Enclosure 1. The spreadsheets were used to develop the cost estimates for Mitretek's 3-line process:

- Table F-1.1 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Summary of Costs by Fiscal Year (TY04$)
- Table F-1.2 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Summary of Costs by Fiscal Year (CN04$)
- Table F-1.3 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Summary of Systemization, Operations, and Closure Staffing Costs
- Table F-1.4 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Summary of Project Services Costs – Construction Through Closure
- Table F-1.5 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Project Services Staffing Matrix
- Table F-1.6 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Systemization, Operations, and Closure Staffing Costs
- Table F-1.7 – PCAPP LCCE – Mitretek 3-Line "Base Case:" Closure Staffing Matrix
- Table F-1.8 – PCAPP LCCE – Mitretek 3-Line "Base Case" Process: Staffing Phase (FTEs) Breakdown

F.2 Cost Spreadsheets for 2-Line Process Alternative

This section of the appendix lists the outputs and supporting cost input spreadsheets for the 2-line process alternative evaluated by Mitretek, which can be found electronically in Enclosure 1. The spreadsheets were used to develop the cost estimates for Mitretek's 2-line process alternative:

- Table F-2.1 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Summary of Costs by Fiscal Year (TY04$)
- Table F-2.2 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Summary of Costs by Fiscal Year (CN04$)
- Table F-2.3 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Build Cost Savings
- Table F-2-4 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Summary of Systemization, Operations, and Closure Staffing Costs
- Table F-2-5 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Summary of Project Services Costs – Construction Through Closure
- Table F-2-6 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Project Services Staffing Matrix

- Table F-2-7 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Systemization, Operations, and Closure Staffing Costs
- Table F-2.8 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Closure Staffing Matrix
- Table F-2.9 – PCAPP LCCE – Mitretek 2-Line Process Alternative: WBS, Schedule and Staffing Plan
- Table F-2.10 – PCAPP LCCE – Mitretek 2-Line Process Alternative: Staffing Phase (FTEs) Breakdown

F.3 Cost Spreadsheets for Mitretek Recommended Process (2-Line Process with Offsite Disposal)

This section of the appendix lists the outputs and supporting cost input spreadsheets for the 2-line process alternative evaluated by Mitretek, which can be found electronically in Enclosure 1. The spreadsheets were used to develop the cost estimates for Mitretek's 2-line process alternative:

- Table F-3.1 – PCAPP LCCE – Mitretek Recommended Process: Summary of Costs by Fiscal Year (TY04$)
- Table F-3.2 – PCAPP LCCE – Mitretek Recommended Process: Summary of Costs by Fiscal Year (CN04$)
- Table F-3.3 – PCAPP LCCE – Mitretek Recommended Process: Build Cost Savings
- Table F-3.4 – PCAPP LCCE – Mitretek Recommended Process: Summary of Systemization, Operations, and Closure Staffing Costs
- Table F-3-5 – PCAPP LCCE – Mitretek Recommended Process: Summary of Project Services Costs – Construction Through Closure
- Table F-3.6 – PCAPP LCCE – Mitretek Recommended Process: Project Services Staffing Matrix
- Table F-3.7 – PCAPP LCCE – Mitretek Recommended Process: Systemization, Operations, and Closure Staffing Costs
- Table F-3.8 – PCAPP LCCE – Mitretek Recommended Process: Closure Staffing Matrix
- Table F-3.9 – PCAPP LCCE – Mitretek Recommended Process: WBS, Schedule and Staffing
- Table F-3.10 – PCAPP LCCE – Mitretek Recommended Process: Staffing Phase (FTEs) Breakdown

Enclosure 1 CD-ROM of Mitretek Assessment Spreadsheets and Drawings

The spreadsheets used in the cost analysis are listed below and can be found electronically on the CD-ROM included as Enclosure 1.

{CD-ROM not included in this special version of the report}