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APPROVAL

Prepared by

Matthew Champagney
Principal Project Manager
ECMS SPA BCA Lead
Parsons

Date: May 19, 2016

Concurrence by

Thomas Robinson, NA-522
Construction Program Manager, Office of Infrastructure, Operations, & Modernization
National Nuclear Security Administration

Date: May 20th, 2016

Concurrence by

Jessica Arcidiacono, NA-533
Office Director, Office of Environmental and Sustainability
National Nuclear Security Administration

Date: May 31, 2016

Concurrence by

Stephen Fong, NA-LA
Project Manager, TA-3 Steam Plant Replacement
National Nuclear Security Administration

Date: May 31, 2016

Concurrence by

Tony Trujillo, NA-APM-20
Project Integrator, Office of Acquisition and Project Management
National Nuclear Security Administration

Date: May 31, 2016

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ACRONYMS

BCA	Business Case Analysis
CD	Critical Decision
CEQ	Council on Environmental Quality
CGTG	combustion gas turbine generator
CHP	combined heat and power
D&D	deactivation and demolition
DOE	Department of Energy
EO	Executive Order
ESCO	energy service company
ESPC	Energy Savings Performance Contract
FY	fiscal year
GPP	general plant project
HRSG	heat recovery steam generator
LANL	Los Alamos National Laboratory
LCCE	life cycle cost estimate
NNSA	National Nuclear Security Administration
NPV	net present value
O&M	operations and maintenance
OMB	Office of Management and Budget
OPC	other project cost
ROM	rough order of magnitude
SMSi	Strategic Management Solutions
SPA	Steam Plant Acquisition
STG	steam turbine generator
TA-3	Technical Area 3
UI-DO	Utilities & Infrastructure Division Office

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1 OVERVIEW

1.1 Purpose

This Steam Plant Acquisition (SPA) Business Case Analysis (BCA) evaluates the use of an Energy Savings Performance Contract (ESPC) to fulfill the shortfalls identified in the Mission Gap Description and the Program Requirements dated March 31, 2016, submitted by Los Alamos Field Office to NA-50. The Business Case quantifies the government's cost, business, economic, risk, and technical arguments of the ESPC approach relative to the existing baseline case and a traditional line-item construction project for the purpose of understanding the magnitude of cost premiums resulting from the use of an ESPC. The results of the business case will be used as the quantitative basis for procurement, investment, and program management decisions.

1.2 Problem Statement

The mission need for the SPA Project is to provide a reliable, efficient, and sustainable heat and electrical supply to support programs and activities conducted in Technical Area 3 (TA-3) facilities, which are essential to the maintaining the nation's nuclear deterrent.

The first mission gap is that the existing steam system is aged, inefficient, and expensive to maintain and operate, and it will not support the future Los Alamos National Laboratory (LANL) mission in a sustainable manner that satisfies the National Nuclear Security Administration (NNSA) and Department of Energy (DOE) requirements without substantial investment. The second mission gap is that the electrical import capacity to the LANL site is insufficient to satisfy future demand and that the site lacks sufficient capability to operate in an "island mode" if the external electrical supply to the site is severely disrupted. Third, environmental compliance associated with Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*, and DOE Order 436.1, *Departmental Sustainability*, includes reducing LANL's carbon footprint and greenhouse gas emissions, and cannot be supported with the existing facilities.

Technical analysis has been performed and has shown that adding a heat recovery steam generator (HRSG) will close the above-stated gaps. This report evaluates the contracting methodologies to execute the project: an ESPC or the traditional line item project.

1.3 Background and Context

Since 2008, extensive study and analysis have been conducted to define the existing condition, current and future requirements, and potential solutions to resolve the mission gap. The LANL Steam Plant Project Report by Bechtel National, Inc. (September 2009) provides a detailed study of the existing steam system and central plant, as well as concepts to improve and upgrade functionality.

The existing combustion gas turbine generator (CGTG) is a Rolls Royce RB-211 gas turbine that was commissioned in 2008. Its capacity is approximately 24 MW. The concept is to fit the CGTG with a HRSG. The steam output from the HRSG would power a new steam turbine generator (STG) to produce approximately 10 MW of additional electricity. The existing three low-pressure turbine generators and facility (placed in service in the early 1950s) will be demolished.

LANL currently fulfills its power needs through a combination of owned generation and market purchases, a strategy that has served to keep the lab's power expenditures lower than the market price. Due to more stringent greenhouse gas emission limits, LANL is likely to lose a major generation source, the coal-fired San Juan Generating Station, as early as 2022. The proposed CGTG/HRSG generating capacity would help to offset the amount of power that would need to be purchased at market prices.

The CGTG controls will also be retrofitted to enable "black start" so that the unit can provide power to the site in an island mode and will require operation in parallel with other power supply or the external grid.

1.4 Project Initiatives and Requirements

As discussed in detail in the *Steam Plant Acquisition Project Program Requirements* document (March 2016), this project has eight primary requirements:

- P1 Provide Steam Heating Capability
- P2 Provide Improved Electrical Service Capability
- P3 Meet requirements of EO 13693, *Planning for Federal Sustainability in the Next Decade* and DOE Order 436.1, *Departmental Sustainability*
- P4 Minimize Disruption to Ongoing Programs during Project Execution
- P5 Meet schedule requirements
- P6 Meet general requirements (regulatory, etc.)
- P7 Meet functional requirements
- P8 Meet Quality Assurance requirements

1.5 Scope

Parsons performed a business case analysis using both quantitative and qualitative methods to fully define economic impact and risks to the government.

As the basis of the BCA, Parsons used the information provided by NA 52 and NA 53, including preliminary engineering and economic feasibility studies. See Appendix A for a list of reference documents used to generate this report. Parsons assumed that the technical studies were valid. Parsons sought an explanation of a few items and received the needed clarification.

The business case quantified the time-phased total life-cycle cost and cash flow analysis of the following:

- An ESPC based on Alternative 3 as detailed in the *Steam Plant Replacement Feasibility Analysis Summary* (17 January 2014). It is assumed that the ESPC will be awarded in fiscal year (FY) 2017 and the new plant will be operational in FY2022.
- Current state. It is assumed that a lump-sum investment will be required every 10 years beginning in FY2020 in order to maintain plant operations.
- Appropriated line-item budget construction project based on the same alternative chosen for the ESPC case. It is assumed that appropriated funds will not be available before FY2021, the new plant will be operational in 2029, and a lump sum investment in 2020 will be required to maintain existing plant operations.

The ESPC alternative assumes that an ESPC will be awarded in or about May 2017. This alternative assumes that the steam plant will continue to operate as it currently does until the upgrade is complete. The upgrade is to add an HRSG that will improve electrical generation and provide some additional heat for the district heating system. The existing central plant will be replaced by a new plant with boilers appropriately sized to supply steam to the distribution system when the CGTG/HRSG is not operating. This analysis assumed no additional improvements, such as replacing steam lines or adding a high-pressure natural gas line. These options might be explored after the ESPC is awarded, or they may be made part of a separate contract. The CGTG/HRSG will operate 90 percent of the year, which is the maximum time allowed.

The Current State Alternative assumes that the plant will continue to operate with lump-sum upgrades every 10 years in order to keep the plant running for an additional 30 years. The CGTG will be run in a limited fashion for maintenance and to keep personnel trained.

The Line-Item Alternative assumes that the plant is run as outlined in the Current State Alternative until the HRSG upgrade can be programmed, funded, and built. The HRSG upgrade is the same as the ESPC alternative and, once completed, the CGTG/HRSG will be run 90 percent of the year.

Risks will be identified and characterized by probability and consequence for the ESPC, base case, and line-item construction approaches.

The scope of the business case analysis spans 30 years. The contract period for the ESPC is 25 years but the study period includes an additional 5 years in order to reach a total useful life of 30 years. Cost accounting followed DOE ESPC guidance (Energy Savings Performance Contracting Process). Parsons used a net present value (NPV) analysis to provide a direct comparison of the alternatives approaches suitable for Senior Executive and potentially external oversight audiences.

The following deliverables are part of this process:

- BCA Work Plan (Delivered 27 April 2016)
- Draft BCA Report (Delivered 6 May 2016)
- Final BCA Report (This report)

This BCA Report includes comprehensive analyses and backup documentation; life cycle costs represented as NPVs for each of the three business cases; detailed analysis of relative, qualitative risks; sensitivity analyses; and final results from the process.

2 ASSUMPTIONS, CONSTRAINTS, AND EVALUATION METHODOLOGIES

2.1 Costing Assumptions and Constraints

The economic analysis provides decision makers with the data required to determine which of the three proposed alternatives for the steam plant provides the best approach to supply steam and electrical services to LANL in the future. The limited scope and accelerated schedule of the analysis did not include development of cost estimates for the three alternatives; therefore, projected costs and input data used in the model were supplied by NA 52 and NA 53 or were determined during onsite meetings with Utility & Institutional Facilities Division, Project Management, and other personnel at LANL. SPA BCA team members are listed in Appendix B.

2.1.1 Assumptions

Assumptions for this analysis are as follows:

- Each alternative has a 30-year useful life after the facility begins operation.
- Because the time required for planning and implementation varies by alternative, the study period also varies in order to reach the 30-year useful facility life.
- The escalation rate for natural gas is 3.5 percent per year based on data provided from DOE energy analysts, Keres Consulting, Inc.
- An escalation rate of 2.0 percent per was applied to all other costs. This rate was determined by reviewing the historical Consumer Price Index and assessing the difference in the Office of Management and Budget (OMB) nominal discount rate and real discount rate.
- The discount rate of 1.35 percent is based on the real discount rate published in OMB A-94, Appendix C.
- Maintenance costs for the existing steam plant are increased by 3 percent per year to account for the effect of the facility's age on the maintenance requirements (the facility is currently approximately 60 years old).
- Maintenance costs for the new steam plant are increased by 2 percent per year beginning in the 11th year of operation to account for the effect of the facility's age on the maintenance requirements.
- The design, construction, and operational demonstration duration for the ESPC alternative is 5 years (based on the schedule for the ESPC in the 2014 Strategic Management Solutions (SMSi) study).
- The design and construction schedule for the Line Item alternative is 8 years (this project will likely be a design-build project and will meet the requirements of DOE Order 413.3 B).
- Costs for labor, commodities, and materials associated with the operation of the steam plant are funded from the LANL burden pool and do not receive a LANL burden assessment.

- Costs for general plant project (GPP) upgrades and Line Item projects would receive a LANL burden multiplier of 1.235.
- Labor from outside the Utility & Institutional Facilities Division will receive a LANL burden multiplier of 2.269.
- Appropriated funds for a Line Item project will not be available until at least FY2021.
- The ESPC will not be required to comply with DOE Order 413.3B requirements.
- The ESPC and Line Item alternatives will provide equal capabilities.
- If the ESPC alternative is chosen, the current schedule projects the award of the ESPC in May 2017.
- The study period will begin in FY2017 for each alternative; because of differing planning and implementation periods, the study period duration varies for each alternative.

The following assumptions regarding the deactivation and demolition (D&D) of both the existing steam plant and the proposed combined heat and power (CHP) plant comply with NNSA and GAO guidance for cost analysis. Although the actual useful lives of the facilities and timeframes for D&D cannot be accurately predicted, for purposes of this study the following is assumed:

- For the ESPC and Line Item alternatives, it is assumed that the existing steam plant will be demolished immediately after the transition to the new facility.
- For the existing steam plant alternative, the existing steam plant will be demolished immediately following its 30-year useful life.
- The new facilities constructed in the ESPC and Line Item alternatives will be demolished immediately following their 30-year useful lives.

2.1.2 Constraints

Constraints for this analysis are as follows:

- Some costs used in the study (e.g., demolition costs) are based on team discussions, LANL historical data, prior cost studies, or rough order of magnitude (ROM) estimates.
- The existing steam plant alternative does not provide capabilities equal to the other two alternatives; hence, costs can be compared but they are not based on similar capabilities.
- None of the costs evaluated in this study includes any upgrade to the steam and condensate distribution system.
- None of the alternatives evaluated in this study includes extension of the high-pressure natural gas supply line.
- The schedules for the ESPC and Line Item alternatives are based on the expected timing for the ESPC award and the earliest possible Line Item funding availability.

2.2 Non-Financial Assumptions and Constraints

This BCA focused on the financial aspects of the different alternatives. Therefore, no non-financial assumptions or constraints affect this analysis.

2.3 Other Constraints

This project would be performed within a national laboratory setting and construction and operations would be subject to limited security access. The alternatives chosen for this BCA are all to be performed in the power plant area, making access constraints uniform across all alternatives. In the event that some combination of technical options not considered in this study (e.g., upgrading the steam lines) are added to the project at a later date, their effects will not be differentiable between the alternatives and will not change the relative ranking of the alternatives.

2.4 Economic Viability Assessment Methodology

2.4.1 Methodology

To analyze the viability of the three alternatives, a life cycle cost estimate (LCCE) was developed for each. The LCCEs include all anticipated costs associated with the alternatives over the study period. Costs were entered into the model for specific cost elements as unescalated, constant year FY2017 dollars, by fiscal year, over the study period. The duration of the study period varies for each alternative. Escalated costs and NPV costs were calculated for each cost element using the constant year input data.

From the completed model, escalated costs, constant year FY2017 costs, and NPV costs were summarized by fiscal year and by cost element over the entire study period. Fiscal year costs for both the ESPC and Line Item alternatives were compared to those of the existing facility alternative to determine the potential savings. This data was also used to determine the break-even year for the ESPC and Line Item alternatives. In addition, the model calculated the total NPV for each alternative.

The results provide adequate discrimination between the alternatives, therefore supplemental measures were deemed unnecessary to further define the relative financial advantages of the alternatives.

2.4.2 Cost Elements

The use of standard cost elements provided a mechanism to compare the projected costs for each alternative more efficiently. Cost elements can include the following:

- Investment costs for both the existing and new facilities
- Operation costs for the existing and new facilities, including savings from replacement of electrical power purchases from the utility grid with power generated on site
- Commodity costs for the existing and new facilities

- Maintenance costs for the existing and new facilities
- Demolition costs for the existing and new facilities

2.4.3 Life Cycle Cost Estimates

The LCCE for each alternative includes different categories of costs within the cost elements, which represent the difference in approach for each alternative.

2.4.3.1 Alternative 1 – ESPC

If chosen as the path forward, the ESPC contract will be awarded by the middle of FY2017. This award will begin the design and construction process for the new facility. Operation of the new facility will not begin until FY2022, and a 1-year transition period will be required before the existing steam plant can cease operation. The existing steam plant will stay in operation through FY2022. It is assumed that demolition of the abandoned steam plant will begin in FY2023. Although the amortization period for the ESPC is 25 years, the new facility will operate for 30 years beginning in FY2022 and running through FY2051. Demolition of the ESPC facility will begin in FY2052 and will be completed in 3 years. It is assumed that neither the D&D of the existing steam plant nor the end-of-life D&D of the proposed CHP will be financed through the ESPC contract. These D&D activities represent real costs and are included in all alternatives, as applicable, so that all options are evaluated equally. The LCCE for Alternative 1 was developed with the following assumptions specific to the alternative.

- No major upgrades to extend the life of the existing steam plant are anticipated for the ESPC Alternative.
- The existing steam plant will continue to operate through FY2022 with operation costs, commodity costs, and maintenance costs.
- Maintenance costs for the existing facility will increase by 3 percent per year through FY2020 due to the age of the facility.
- Maintenance costs for the existing facility will begin to reduce in the last 2 years as the new facility nears operation and the existing facility nears shutdown.
- It is assumed that the existing facility will be demolished beginning in FY2023; demolition will continue for 3 years. Associated costs will not be included in the ESPC contract.
- The salvage value of the existing steam plant is primarily in the turbines, which were recently upgraded.
- Design, construction, and operational demonstration of the new facility will begin in FY2017 and will continue for 5 years.
- LANL Utility & Institutional Facilities Division will provide implementation support during the design and construction period, continuing through the transition year at a reduced rate.
- The new facility will begin operation in FY2022 and continue to operate through FY2051.

- The yearly amortization payments for the ESPC will continue for 25 years beginning in FY2022.
- The new facility will have periodic upgrades during its life in order to maintain operational efficiency.
- Maintenance costs for the new facility will increase by 2 percent per year beginning in the 11th year of operation due to aging of the facility.
- The maintenance costs for the new facility will begin to reduce in the last 2 years of operation as the facility nears shutdown.
- The cost of the purchased electricity that will be replaced by the new facility is shown as operations cost savings in the model.
- Demolition of the new facility will begin in FY2052 and will continue for 3 years. Associated costs will not be included in the ESPC contract.
- The salvage value for the ESPC facility is projected to be similar to that of the existing facility in FY2017 dollars.
- The majority of the costs included for the ESPC facility were derived from the 2014 Strategic Management Solutions (SMSi) Steam Plant Study.
- The majority of the costs included for the existing facility were developed during on-site meetings with LANL personnel and are based on current budgets, previous cost estimates, and ROM estimates.
- Costs in the model are segregated into phases, including Implementation, Transition, Operation, and D&D.

2.4.3.2 Alternative 2 – Existing Facility

This alternative is based on continued operation of the existing steam plant for an additional 30 years beginning in FY2017. Extending the life of the existing steam plant will require significant periodic upgrades beginning in FY2020 and repeating every 10 years. The costs for the upgrades were developed during discussions with LANL Utility & Institutional Facilities Division personnel who were familiar with current deferred maintenance and capital improvement needs. The existing steam plant will stay in operation through FY2046. Demolition of the abandoned steam plant will begin in FY2047 and will continue for 3 years. The LCCE for Alternative 2 was developed with the following assumptions specific to the alternative.

- Significant investments in the existing facility will begin in FY2020 and will be repeated every 10 years with the last upgrade occurring in FY2040.
- The existing steam plant will continue to operate through FY2047 with operation costs, commodity costs, and maintenance costs.
- Maintenance costs for the existing facility are increased by 3 percent per year to account for the age of the facility.

- Maintenance costs will reduce in the last 2 years as the existing facility nears shutdown.
- The existing facility will be demolished beginning in FY2048; demolition will continue for 3 years.
- The salvage value of the existing steam plant is expected to be negligible at the end of its useful life.
- The majority of the costs included for the existing facility were developed during on-site meetings with LANL personnel and are based on current budgets, previous cost estimates, and ROM estimates.
- Costs in the model are segregated into phases, including Operation and D&D.

2.4.3.3 Alternative 3 – Line Item Project for New Steam Plant

If chosen as the path forward, the Line Item approach will require Critical Decision 1 (CD-1) approval before initiating a design-build contract for the facility. The earliest date that Line Item funding will be available is FY2021, and a risk of further delay in receiving funding does exist. Award of the design-build contract in FY2021 will begin the design and construction process for the new facility. Operation of the new facility will not begin until FY2029, and a 1-year transition period will be required before the existing steam plant can cease operation. The existing steam plant will stay in operation through FY2029, and demolition of the abandoned steam plant will begin in FY2030. Because this alternative requires the existing steam plant to continue operation for 13 years, one significant upgrade is planned in FY2020 to help extend the life of the facility. The new facility will operate for 30 years beginning in FY2029 and will run through FY2058. Demolition of the Line Item facility will begin in FY2059 and will be completed in 3 years. The LCCE for Alternative 2 was developed with the following assumptions specific to the alternative.

- One major upgrade will be required in FY2020 to extend the life of the existing steam plant through the FY2029 transition year.
- The existing steam plant will continue to operate through FY2029 with operation costs, commodity costs, and maintenance costs.
- Maintenance costs for the existing steam plant will increase by 3 percent per year through FY2027 due to the age of the facility.
- Maintenance costs for the existing facility will begin to reduce in the last 2 years as the new facility nears operation and the existing facility nears shutdown.
- The existing facility will be demolished beginning in FY2023; demolition will continue for 3 years.
- The salvage value of the existing steam plant is primarily in the turbines, which were recently upgraded.
- Design, construction, and operational demonstration of the new facility will begin in FY2017 and will continue for 8 years.

- LANL Utility & Institutional Facilities Division personnel, as well as LANL Engineering personnel, will provide implementation support from the time CD-0 approval is received through the design and construction period, and continuing through the transition year at a reduced rate.
- The new facility will begin operation in FY2029 and will continue through FY2058.
- The new facility will have periodic upgrades during its life in order to maintain operational efficiency.
- Maintenance costs for the new facility will increase by 2 percent per year beginning in the 11th year of operation due to aging of the facility.
- The maintenance costs for the new facility will begin to reduce in the last 2 years of operation as the facility nears shutdown.
- The cost of the purchased electricity that will be replaced by the new facility is shown as operations cost savings in the model.
- Demolition of the new facility will begin in FY2059 and will continue for 3 years.
- The salvage value for the ESPC facility is projected to be similar to that of the existing facility in FY2017 dollars.
- The majority of the costs included for the Line Item facility were derived from the FY2014 SMSi Steam Plant Study.
- The majority of the costs included for the existing facility were developed during on-site meetings with LANL personnel and are based on current budgets, previous cost estimates, and ROM estimates.
- Costs in the model are segregated into phases, including Implementation, Transition, Operation, and D&D.

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3 DESCRIPTION OF ALTERNATIVES

3.1 ESPC

The ESPC alternative assumes that an ESPC will be awarded in or about May 2017. This alternative assumes that the steam plant will continue to operate as it currently does until the upgrade is complete. The upgrade is to add an HRSG, which will improve electrical generation and provide some additional heat for the district heating system. The existing central plant will be replaced by a new plant with boilers appropriately sized to supply steam to the distribution system when the CGTG/HRSG is not operating. This analysis assumed no additional improvements, such as replacing steam lines or adding a high-pressure natural gas line. These are options that might be explored after the ESPC is awarded, or they might be made part of a separate contract. The CGTG/HRSG will operate 90 percent of the year, which is the maximum time allowed.

3.2 Existing Steam Plant

The Current State Alternative assumes that the plant will continue to operate with lump-sum upgrades every 10 years beginning in 2022 in order to keep the plant running for an additional 30 years. The CGTG will be run in a limited fashion for maintenance and to keep personnel trained.

3.3 Line-Item

The Line-Item Alternative assumes that the plant is run as outlined in the Current State Alternative until the HRSG upgrade can be programmed, funded, and built. The HRSG upgrade is the same as the ESPC Alternative and, once completed, the CGTG/HRSG will be run 90 percent of the year.

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4 COMPARISON OF ALTERNATIVES

4.1 Comparison of Alternatives Economic Viability Measures

The economic viability measures for each alternative are primarily driven by three factors: the timing of the alternative, the ability to generate power savings, and the required funding requirements.

4.1.1 Alternative 1 – ESPC

The ESPC Alternative provides a new facility much more quickly than does the Line Item Alternative because the planning and approval process is much less cumbersome and the implementation period is shorter. These two characteristics allow the ESPC to be awarded much more quickly and design-build to be completed by FY2021, the same year the Line Item Alternative would receive funding to begin design. The ESPC Alternative allows the existing steam plant to cease operations sooner and begins to provide savings from power generation 7 years before the Line Item Alternative. Although the existing steam plant begins operation immediately, it can never provide savings to LANL from power generation. The cumulative cash flow is less for the ESPC Alternative than for either of the other two alternatives. When the cumulative power generation savings are compared to the total ESPC cost, the results show that the power savings will offset the cost of the ESPC in the 12th year of operation.

4.1.2 Alternative 2 – Existing Steam Plant

The existing steam plant begins operation immediately and therefore involves no cost for planning and implementation of design or construction. This alternative has two major negative attributes: (1) it can never provide savings to LANL from power generation, and (2) because of the age of the facility, the maintenance costs increase over time at a rate much greater than the other two alternatives. The lack of power generation savings is the primary drawback for this alternative because the lack of power generation savings results in a much greater cumulative cash flow than for the ESPC Alternative.

4.1.3 Alternative 3 – Line Item

The Line Item Alternative provides a new facility and power generation savings, but it requires a much longer planning and implementation period than the ESPC Alternative. Furthermore, funding constraints delay the start of design until at least FY2021 and possibly longer. These two limitations require that the existing steam plant stay in operation for a longer period and delays the start of power generation savings. Possibly the greatest limitation for the Line Item Alternative is the required cash flow during implementation. The Line Item approach requires that all funding for the new facility be received and expended during design and construction. This places a great strain on the available funding stream and could make this approach impossible in the near future.

4.2 Comparison of Costs and Savings

The analysis provides economic measures for each alternative, including total escalated cost over the study period, total NPV over the study period, escalated cash flow and cumulative escalated cash flow, break-even point for the ESPC vs. the existing steam plant, and break-even point for the Line Item vs. the Existing Steam Plant. As shown in Tables 4-1 and 4-2, every measure indicates that the ESPC is the best economic choice for future steam and electrical supply at LANL.

Table 4-1: Escalated Cost Range
(Dollars in Millions)

	ESPC			Existing Facility			Line Item		
	Low Range	Point Est.	High Range	Low Range	Point Est.	High Range	Low Range	Point Est.	High Range
Investments	0	0	0	32	49	80	104	160	265
Operation	25	31	42	158	198	267	–66	–55	–36
Maintenance	153	191	258	177	222	299	202	253	341
D&D	33	51	85	30	46	76	38	59	97
Total Escalated Cost	211	273	384	397	514	723	278	417	667

Table 4-2: Net Present Value Cost Range
(Dollars in Millions)

	ESPC			Existing Facility			Line Item		
	Low Range	Point Est.	High Range	Low Range	Point Est.	High Range	Low Range	Point Est.	High Range
Investments	0	0	0	20	31	52	80	124	204
Operation	30	30	51	86	107	145	–44	–36	–24
Maintenance	84	84	142	103	128	173	100	125	169
D&D	19	19	47	11	16	27	17	26	43
Total NPV Cost	133	133	240	220	284	397	154	239	392

The tables above show three estimates for each alternative: the point estimate generated by the cost model, and low and high range estimates that were calculated based on confidence levels for each cost element. Investment and Demolition costs have a Class 5 Estimate range of –35%/+65%, while Operations and Maintenance costs have narrower Class 4 Estimate range of –20%/+35%. Figures 4-1 and 4-2 show the total escalated costs and net present value costs, respectively, for each of the alternatives. The costs are based on the point estimates in Tables 4-1 and 4-2.

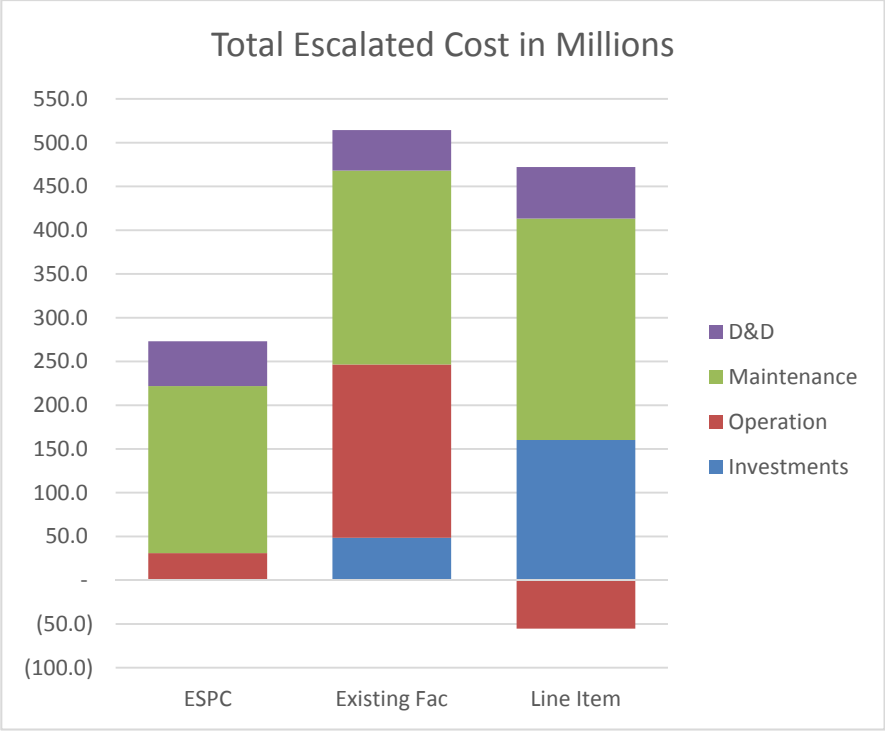

Figure 4-1: Total Escalated Cost

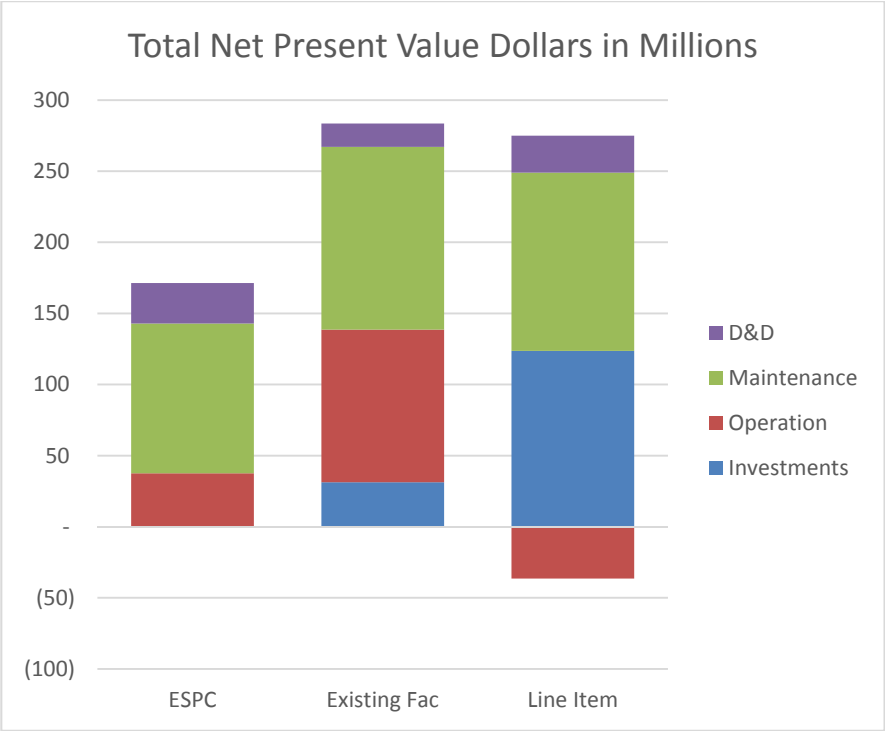

Figure 4-2: Net Present Value

Figures 4-3 and 4-4 demonstrate the cumulative savings estimated for the ESPC and Line Item compared to operating the existing facility. The ESPC shows negative savings compared to the existing facility through FY2019, the driver being LANL expending OPCs in support of the ESPC, then positive savings in FY2020 when the existing plant is assumed to require a significant facility investment. The cumulative savings are estimated to be negative in FY2022, the first year of operation when ESCO payments begin and it is assumed that costs are incurred for D&D of the existing facility. Relative savings continue to trend downward until the D&D is complete, and then trend upward thereafter. The ESPC breaks even relative to the existing facility after 8 years of operation in FY2028, and the relative savings increase through FY2049 when the existing plant is assumed to be deactivated and disposed of, ending the comparison.

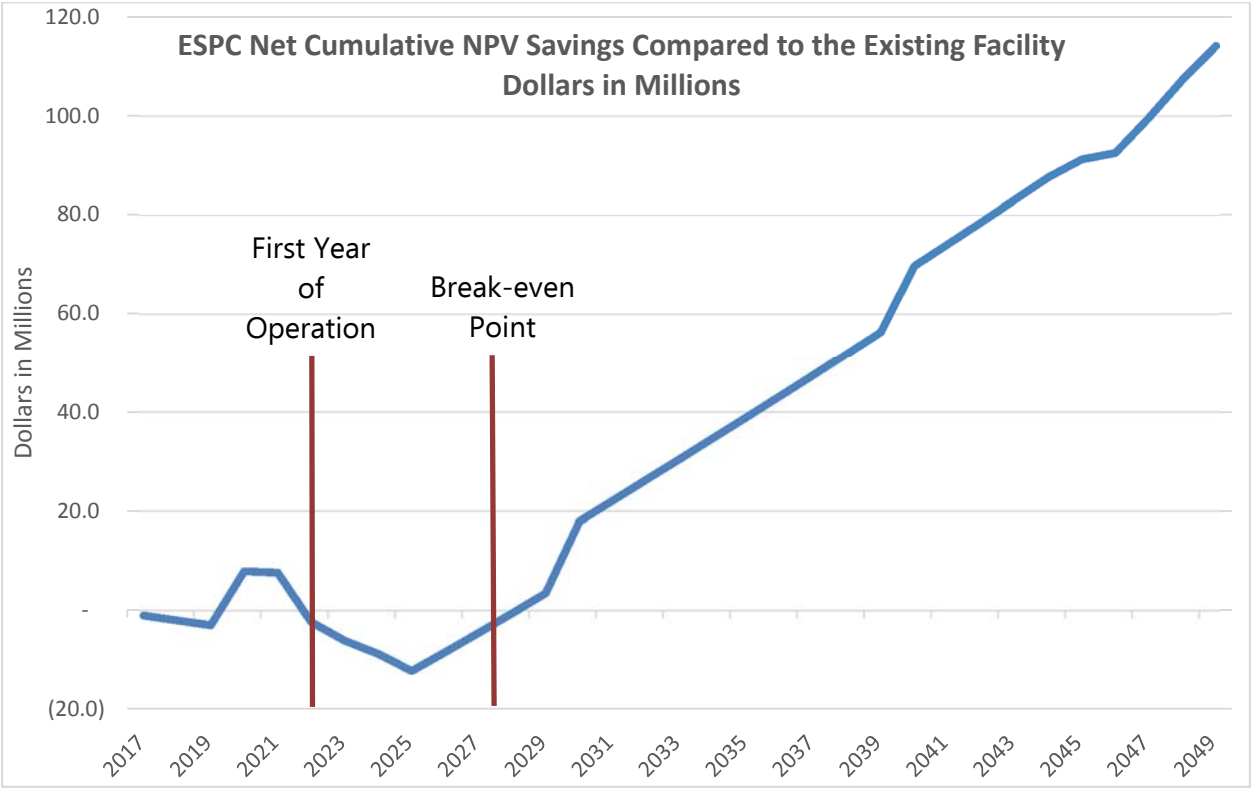

Figure 4-3: Cumulative NPV Savings – ESPC vs. Existing Facility

The line item alternative requires significant capital investment and therefore shows significant negative savings relative to the existing facility until the start of operations in FY2029. Relative savings trend upward from this point. The line item facility breaks even in FY2045 and accumulates relative savings until the end of the comparison period in FY2049 when the existing plant is assumed to be deactivated and disposed of.

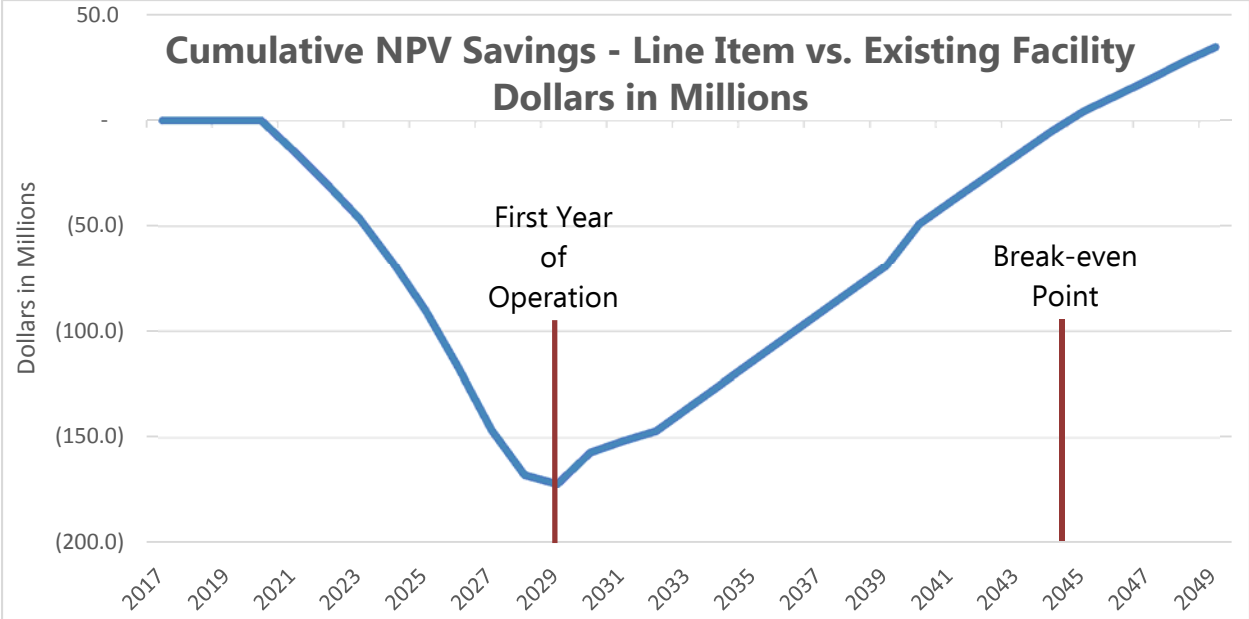

Figure 4-4: Cumulative NPV Savings – Line Item vs. Existing Facility

Figure 4-5 shows the cumulative escalated cash flow for each alternative. The study period for each alternative ends 30 years after start of operations, therefore the cash flow curve for the existing facility ends earlier than that for the ESPC. The line item project has the longest initial duration to start of operations and therefore extends further than the other curves. The comparison shows that, based on 30 years of assumed operation, the ESPC alternative has the lowest cumulative cash flow.

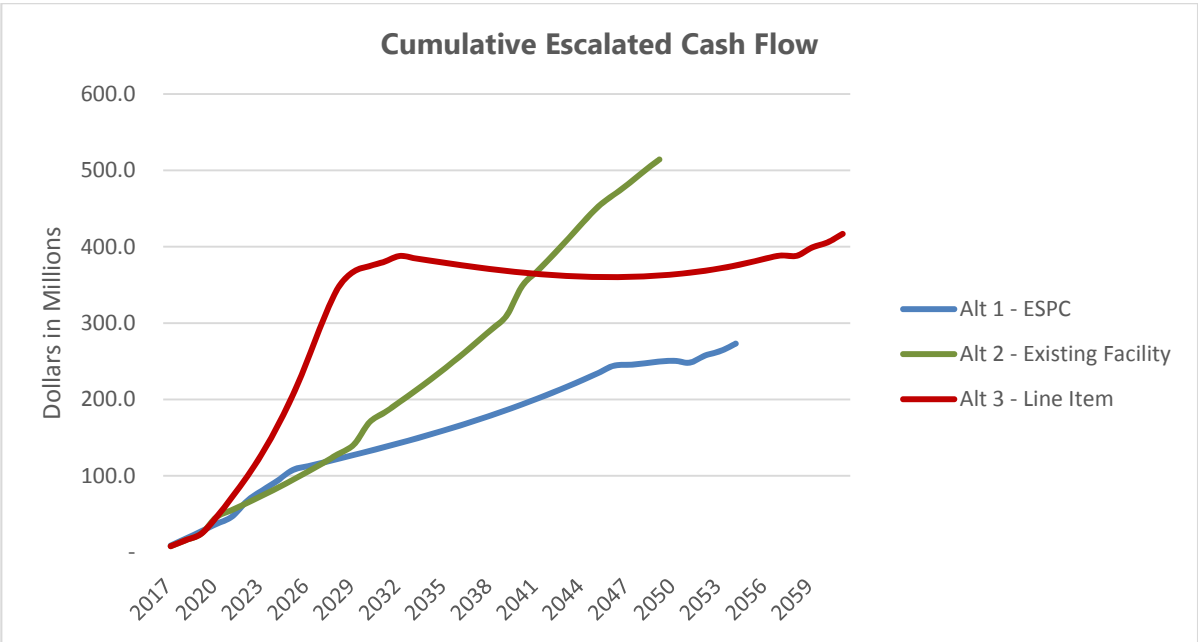

Figure 4-5: Cumulative Escalated Cash Flow

4.3 Cost Sensitivity Analysis

To determine the possible effect of cost attribute changes on the results of the analysis, a sensitivity analysis was performed. Attributes that influence the model were individually analyzed to determine their effect on the NPV, Break-even Period, and NPV savings. Because the Break-even Period and NPV savings are based on comparison with the existing facility alternative, there are no Break-even Period or NPV savings for the Existing Facility.

In order to analyze the effect of changes in the attributes on the model, each was independently varied by –20% to +20% and the results on the analysis results were observed. The results were then tabulated to get an indication of which attributes have the most potential to affect the conclusions of the analysis. The results are presented in tabular and graphic format in the appendices.

The sensitivity analysis captured the effects of the following cost attributes:

- The discount rate used to calculate NPV
- The interest rate used to calculate the required yearly payment to the ESPC over the 25-year contract period
- The capital cost for new facilities to be constructed in the ESPC and Line Item Alternatives
- The commodity cost including natural gas fuel for power and steam generation
- The estimated cost savings associated with purchased power that will be replaced with that generated by the new facility

The estimated cost savings associated with replacement of purchased power is the only attribute that affected the savings enough, within the bounds of the sensitivity analysis, to make either of the replacement alternatives no longer viable. If the actual power cost savings are 20% less than projected, the Line Item alternative becomes less economically attractive than the existing facility. Even at this level of reduction however, the ESPC alternative remains economically attractive when compared to the existing facility.

Two other attributes, commodity costs and capital costs for new facilities, have a moderate effect on the results, but within the bounds of the sensitivity analysis, neither affects the results in such a way that either the ESPC or Line Item alternatives becomes less attractive than the existing facility.

The final two attributes, the interest rate for the ESPC and the discount rate, only have a minor effect on the results of the analysis.

For more detailed information about the life cycle cost estimates and sensitivity analyses, please refer to the Excel workbook *LANL SPA BCA Cost Model Rev0* transmitted with this report.

4.4 Risk Comparisons

4.4.1 Background/General

Due to the level of maturity of the project (preconceptual), a quantitative analysis of the threats and opportunities (risks) reflecting any credible numeric values that were useable in a decision process was not deemed to be reasonable.

However, relativistic comparisons of qualified probabilities of occurrence and consequences for these risks can reasonably be developed and used as factors in decision making and planning for the development and execution of the project, particularly in relation to the acquisition strategy. This approach to comparing relative risks assumes and reflects the engagement of the experienced, subject matter expert (SME)-level site operations and maintenance (O&M), program and project personnel/expertise, and experience brought forth through the SPA-BCA team members engaged in this assessment.

The three cases listed below were assessed for threats and opportunities (risks) associated with (1) meeting mission objectives, (2) meeting programmatic objectives, (3) execution risks, and (4) minimizing vulnerabilities in the O&M of, and modifications to, the existing utility systems:

- Do nothing (continued incremental O&M investments)
- Full scope using Design-Build /Line Item acquisition strategies
- Full scope using Design-Build/ESPC/Energy Service Company (ESCO) acquisition strategies

Given these three cases, it is important in interpreting the results of this qualitative analysis that the reader recognize that two fundamental perspectives/questions are inherently imbedded in these three options:

- *Is the Do Nothing case preferred over the Do Something approach?* (e.g., affecting the full scope of either the Line Item or ESPC acquisition strategy, and assuming the basis of the second perspective is to "do something", the second question becomes
- *What is the preferred acquisition method?*

In assessing the threats and opportunities of both of these questions in one risk analysis, the composite results are not distinctly indicative of comparative relevance of one case versus the other, rather, they serve better as stand-alone statements of the assessment of each question against the risks itself. For example, The Do Nothing case is not viable in considering several of the overall risks (e.g., operating in "Island Mode") because this case provides no cost-effective way to generate power. Similarly, mitigating the risk of a system failure due to aging systems, structures, and components is not addressed; rather, it is postponed indefinitely while the risk increases over time. In comparison, both the LI and ESPC acquisition approaches assume a scope that will ultimately provide the capacity to operate cost effectively in Island Mode with the

primary variable being duration to implementation, and both acquisition strategies will minimize and/or eliminate the risk associated with a system failure due to aging components.

Even though the ***composite*** summations of the entire risk register result in a relatively low risk calculation and the case results vary by relatively insignificant amounts, the true relevance of the questions and assessments comprising the composite calculations lies in the individual risks assessed and the probability and consequences associated with each one. For example, only one case (given the assumptions listed below) provides an opportunity to achieve environmental compliance required by EO 13693 and DOE Order 436.1 and reduce LANL's carbon footprint and greenhouse gas emissions, that specific case being Do Something by using an ESPC/ESCO acquisition strategy.

Similarly, many of the other risks identified are equally important and merit programmatic and management attention as individual risks, but their relevance is masked by the composite scoring. Several of these primary areas are discussed in the following sections. The individual risks and the discussions of each are presented in Appendix C.

4.4.2 Risk Summary and Conclusions

4.4.2.1 Primary Risks Associated with Meeting Mission Objectives

The following risks are associated with meeting the mission objectives:

- The existing steam facilities, systems, and structures have exceeded their respective design lives.
- Key components of the existing system are no longer produced, and parts for these systems are no longer available on the current equipment markets.
- The technology associated with many of the control systems is obsolete and is less than optimum to manage a key infrastructure of a research and design organization such as LANL.
- Selected software packages used in the control and management systems are no longer supported by the original manufacturers.

Despite an exemplary effort by the O&M staff at LANL to sustain a high degree of availability of the utilities currently managed, the likelihood of failure of systems and components and the potential for failure of key components will continue to increase.

The expected rate of increase for these failures will be accelerated (perhaps exponentially) as their use is extended beyond design their life. Dependence on these systems without cognizance of this accelerating trend will likely result in an eventual failure of the systems and an extended outage with potential adverse consequences to the missions of the Laboratory.

The Do Nothing (continued incremental O&M investments) case will slow the inevitable rate of expected failure of the systems. However, the challenges associated with mitigating the

degradation of the systems, structures, and components as related above will inevitably become more rigorous and less effective against avoiding failures.

The Full Scope using Design-Build/Line Item Acquisition Strategies case will mitigate the threats listed in this example in the FY2029 timeframe. Meanwhile, the risks associated with the Do Nothing (continued incremental O&M investments) scenario will continue and will increase as defined above for the next 13 to 14 years.

The Full Scope using Design-Build/ESPC/ESCO Acquisition Strategy case will also mitigate the threats listed in this example, but it will likely do so in the FY2022 timeframe, an estimated 7 years in advance of the Line Item acquisition approach, and will also truncate the expected escalation of likely failures under the Do Nothing case.

4.4.2.2 Primary Risks Associated with Meeting Programmatic Objectives

One of the primary programmatic objectives of the project is stated to be *achieving environmental compliance required by EO 13693 and DOE Order 436.1 to reduce LANL's carbon footprint and greenhouse gas emissions*. EO 13693 (signed on 19 March 2015) specifies the following explicit goals and objectives:

- Under Section 1, Policy:
  - *Reduce agency direct greenhouse gas emissions by at least 40 percent over the next decade (emphasis added by author) while at the same time fostering innovation, reducing spending, and strengthening the communities in which our federal facilities operate.*
  - *To improve environmental performance and federal sustainability, priority should first be placed on reducing energy use and cost, while ensuring that federal facilities will continue to meet mission requirements and lead by example.*
  - *Employing this strategy for the next decade calls for expanded and updated Federal environmental performance goals with a clear overarching objective of reducing greenhouse gas emissions across Federal operations and the Federal supply chain.*
- Under Sec. 2. Agency Greenhouse Gas Emission Reductions:
  - *In implementing the policy set forth in section 1 of this order, the head of each agency shall, within 90 days of the date of this order, propose to the Chair of the Council on Environmental Quality (CEQ) and the Director of the Office of Management and Budget (OMB) percentage reduction targets for agency-wide reductions of scope 1 and 2 and scope 3 greenhouse gas emissions in absolute terms by the end of fiscal year 2025 relative to a fiscal year 2008 baseline.*
- Under Subsection (k). Implement performance contracts for Federal buildings by:
  - *Utilizing performance contracting as an important tool to help meet identified energy efficiency and management goals while deploying life-cycle cost-effective energy efficiency and clean energy technology and water conservation measures;*

- *Fulfilling existing agency performance contracting commitments towards the goal of $4 billion in Federal performance-based contracts by the end of calendar year 2016; and*
- *Providing annual agency targets for performance contracting for energy savings to be implemented in fiscal year 2017 and annually thereafter as part of the planning requirements of section 14 of this order.*

The Do Nothing (continued incremental O&M investments) case will not accomplish or support these objectives.

The Full Scope using Design-Build/Line Item Acquisition Strategies case will not accomplish or support these objectives, considering the mandated timeframes for compliance and the scheduled availability of capital funding and the anticipated execution duration.

The Full Scope using Design-Build/ESPC/ESCO Acquisition Strategy case is the only alternative considered in this study that is able to meet all challenges posed by this Executive Order (this alternative will reduce CO_2 emissions by more than 460,000 tons per year beginning in FY2022).

4.4.2.3 Primary Execution Risks

Schedule delays in completion of either of the Full Scope acquisition cases will prolong (beyond the anticipated turnover dates) and sustain the failure risks associated with the aging facilities and declining effectiveness of the Do Nothing (continued incremental O&M investments) efforts.

The Full Scope using Design-Build/Line Item Acquisition Strategies case will be subject to the timely provision of funds required to execute the project without variance from the most aggressive execution schedule. In addition, financial incentives or penalties for late completion of the project are unlikely under this strategy (assuming the equitable negotiation of the financial and schedule impacts of change orders identified after the contract has been awarded).

However, the Full Scope using Design-Build/ESPC/ESCO Acquisition Strategy case is less likely to sustain schedule delays in ultimate turnover of the facilities because (1) it does not depend on the provision of capital funding from the DOE, and (2) the ESCO has significant financial incentive to complete the transition on or ahead of schedule in the form of timely and early reimbursements to the ESCO from DOE from realized energy savings.

4.4.2.4 Primary O&M and Facility Modifications

The primary risks associated with the O&M and facility modifications lie in several areas:

- The current extent of both Full Scope cases primarily focuses on central plant modifications. However, during the project development phase of considering an ESPC acquisition approach, energy savings associated with upgrades, improvements, and replacements of the

distribution systems will be analyzed for potential returns on investment for energy savings. Even though the significance of the impact of as-built conditions varying from the as-discovered conditions, the congested utilities routing and latent subsurface contamination will pose risks for the central plant area, and the probabilities and consequences of these risks will much be greater if work extends (under either the LI or ESPC cases) into the TA-03 distribution systems. These as-discovered conditions include (but are not limited to) the following:

- Explicit and detailed information and/or the lack of information associated with the physical 3-D location of interferences of other systems and utilities.
- Radiological and chemical contamination requiring remediation.
- Seasonal impacts on work that precludes timely outages of utilities; programmatic impacts that preclude timely outages of utilities; etc.

- The financial incentives of energy savings reimbursements for the ESCO will likely result in more favorable schedule recovery efforts under an ESPC arrangement than that experienced under the standard Line Item project execution.

4.4.3 Major Bases and Assumptions

4.4.3.1 Schedule

Schedule assumptions are as follows:

- The earliest date for availability of sufficient capital funds to support the execution of the project scope under the Line Item Acquisition Scenario is FY2021.
- Under the Line Item Acquisition Scenario, the timeframe for the design, procurement, construction, installation, testing, startup, commissioning, readiness assessments, and operational turnover of the new systems, structures, and components is estimated to be in the FY2029 timeframe.
- An energy service company (ESCO) can be selected and an ESPC contract can be awarded by May 2017.
- Under the ESPC Acquisition Scenario, the timeframe for the design, procurement, construction, installation, testing, startup, commissioning, readiness assessments, and operational turnover of the new systems, structures, and components is estimated to be in the FY2022 timeframe.

4.4.3.2 Funding

Funding assumptions are as follows:

- Capital funding for the acquisition under the assumptions of a Congressional Line Item will likely be incremental (over a period of 3 or more years).

- Adequate expense funding and associated capital funding to support the development and execution of the project under both the ESPC and Line Item scenarios will be provided as required to preclude delays in the execution schedules.

4.4.3.3 Regulatory

Regulatory assumptions are as follows:

- The existing air permits can be modified to incorporate the anticipated reduced composite emission levels from the new facilities without major and/or protracted public engagements.

4.4.3.4 Other

Other assumptions are as follows:

- DOE Order 413.3x will not be invoked, nor will it apply to an ESCO performing work on the project under an ESPC.
- DOE Order 413.3x will be invoked and will apply to a contractor performing work on the project under the acquisition as a Congressional Line Item Project.
- Both the Line Item and ESPC Acquisition Strategies will likely propose a design-build approach.

The potential exists to secure an ESPC contract with an ESCO to include the operations and maintenance of the facility for the reimbursement term of the contract (~25 years). Under these conditions, the design, construction, startup, testing and commissioning will only require standard commercial codes and standard as design criteria.

4.4.4 Assessment Methodology

Risk identification and evaluation considered both threats and opportunities (risks). Due to the level of maturity of the project (preconceptual), a quantitative analysis of the threats and opportunities (risks) and the quantification of consequences reflecting any credible numeric values usable in a decision process was not deemed to be reasonable.

However, relativistic comparisons of qualified probabilities of occurrence and consequences for these risks can reasonably be developed and used as factors in decision making and planning for the development and execution of the project, particularly relating to acquisition strategy. This position assumes and reflects the engagement of the experienced, SME-level site O&M, as well as program and project personnel/expertise and experience of the SPA-BCA team members engaged in this assessment.

Furthermore, corollaries of each threat can be represented as opportunities. Therefore, in the interest of consistency, coupled with the early stage of this project development, all postulated cases are defined as “risks.”

For each case, the team rated risks using five-by-five matrices of likelihood vs. consequence (impact or benefit). Figure 4-6 shows an example of the five-by-five matrix used in assessing the threat level for risks.

The probability of occurrence is subjective and relies on the subject matter expertise of those site O&M, project, and program personnel and the BCA team members.

Table 4-3 lists the general guidelines employed by the SMEs in making these probability of occurrence assessments.

Probability of Occurrence (L)						
5	**Very High** >90%	Low	Moderate	High	Very High	Very High
4	**High** 65% – 90%	Low	Moderate	Moderate	High	Very High
3	**Moderate** 35% – 64%	Very Low	Low	Moderate	Moderate	High
2	**Low** 10% – 34%	Very Low	Very Low	Low	Moderate	High
1	**Very Low** <10%	Very Low	Very Low	Very Low	Low	Moderate
		Negligible 1	**Marginal 2**	**Significant 3**	**Critical 4**	**Crisis 5**
		Consequence of Occurrence (C_R)				

Figure 4-6: Threat Level Matrix

Table 4-3: Risk (Threat or Opportunity) Likelihoods

Likelihood of Occurrence	Criteria
Very Low Likelihood (VLL)	An event that is considered not likely to occur at any time in the life cycle of conducting project activities, or The probability of a single event occurrence is less than 10%.
Low Likelihood (LL)	An event that is considered unlikely to occur in the life cycle of conducting project activities, or The probability of a single event occurrence is between 10% and 34%.
Moderate Likelihood (ML)	An event that is considered just as likely as it is unlikely to occur in the life cycle of conducting project activities, or The probability of a single event occurrence is greater than 34% but less than 65%.
High Likelihood (HL)	An event that is considered likely to occur sometime in the life cycle of conducting project activities, or The probability of a single event occurrence between 65% and 90%.
Very High Likelihood (VHL)	An event that is considered very likely to occur sometime in the life cycle of conducting project activities, or The probability of a single event occurrence is greater than 90%.

The consequences (at this stage of the project development) are also primarily dependent on the perspectives of the same SMEs but with some level of subjective, quantified, potential conceptual, financial, schedule and programmatic levels of judgement of the impacts. The levels of consequences used in this assessment are presented in Table 4-4.

Table 4-4: Threat Consequence

Consequence of Occurrence (C_R)	Criteria
Negligible (N)	• Minimal consequences; unimportant. • Some potential transfer of money, but budget estimates not exceeded. • Negligible impact on project; slight potential for critical path schedule change, typically compensated by available schedule reserve. • Negligible impact on program; slight potential for schedule change; typically compensated by available schedule float.
Marginal (Ma)	• Small impact to project or program technical performance. • Moderate threat to facility mission, environment, or people; may require minor facility redesign or repair, minor environmental remediation, or first aid/minor medical intervention. • Cost estimates marginally exceed budget. • Minor slip in project critical path schedule with some potential adjustment to milestones required. • Minor slip in program schedule with some potential adjustment to milestones (deliverable dates) required.
Significant (S)	• Significant to project or program technical performance. • Significant threat to facility mission, environment, or people; requires some facility redesign or repair, significant environmental remediation. • Cost estimates significantly exceed budget of total project cost or annual operating cost. • Major slip in critical path schedule with resulting milestones changes that may affect project delivery. • Major slip in program schedule with resulting milestones changes that may affect facility mission.
Critical (Cl)	• Technical goals of modification/project or program cannot be achieved. • Serious threat to facility mission, environment, possibly completing only portions of the mission or requiring major facility redesign or rebuilding, extensive environmental remediation. • Cost estimates seriously exceed budget. • Excessive critical path schedule slip affecting overall project delivery. • Excessive program schedule slip affecting overall mission of facility/site/DOE objectives, etc.
Crisis (Cs)	• Project or program cannot be completed; operations not sustainable. • Cost estimates that exceptionally exceed budget of total project cost or annual operating cost. • Catastrophic threat to facility mission or environment, possibly causing loss of mission or long-term environmental abandonment.

5 CONCLUSIONS

5.1 Summary Comparison

In terms of NPV, the alternative that spends the least money is the ESPC Acquisition Strategy. The alternative with the second lowest cost is the Line Item Construction. Keeping the existing steam plant without upgrade is the most expensive alternative.

Transition to operations, which is also the point at which reductions in greenhouse gas emissions are realized, occurs soonest for the ESPC Alternative, specifically in FY2022. This is the only alternative that provides greenhouse gas reductions within the mission parameters. Greenhouse gas emission reductions begin in FY2029 for the Line Item Alternative; they are not achieved by continuing to operate the existing plant.

The break-even period is the duration required for the cumulative costs of the ESPC and Line Item alternatives to equal the cumulative costs for the existing facility alternative. At this point, the cumulative costs for the ESPC and Line Item alternatives are consistently less than those for the existing facility alternative, resulting in net savings. For the ESPC alternative, measurement of the break-even period begins in the year of the first payment to the ESCO and consistent net savings begin in the 8th year. For the Line Item alternative, measurement of the break-even period begins in the first year of capital expenditures on the new facility and consistent net savings begin in the 25th year. When the cumulative power generation savings are compared to the total ESPC cost, the results show that the power savings will offset the cost of the ESPC in the 12th year of operation.

From programmatic, execution, and mission objective perspectives, the lowest overall risk is the ESPC Acquisition Strategy. It is important to remember that, as explained in Section 4.3.1, it is not useful to compare the composite risk ratings of one alternative to another's, as different risks are not applicable to all alternatives.

Table 5-1 summarizes the relative costs, estimated dates for start of operations, and risk scores.

Table 5-1: Summary Comparisons

	ESPC	Existing Plant	Line Item
Total Cost (NPV)	$133M to $240M	$220M to $397M	$154M to $392M
Start of Operations (FY)	2022	N/A	2029
Risk Score	Low	Low	Low
Break-even Period	8 Years	N/A	25 Years

5.2 Funding Needs and Sources

The ESPC strategy will need other project cost (OPC) funds to develop and execute the ESPC. The construction will initially be funded by the ESPC and then paid by the cost savings, which are guaranteed by the ESCO. O&M funds and utility costs will be reduced once the project is in place. There will be an annual payment to the ESCO, which will be no more than 95 percent of the demonstrated savings; therefore, cash flow will be less than current projected costs. D&D of the existing steam plant and proposed CHP plant (at end of life) are not included in the ESPC contract and are assumed to require line item funding.

The line item strategy will require construction funds to be congressionally authorized. While the budgeting process takes its course, O&M are projected to increase each year as the plant ages. A revitalization project in FY2020 will require additional funding.

Staying with the current steam plant will require increasing O&M funds yearly and a revitalization project every 10 years beginning in FY2020 to keep the plant running.

APPENDIX A: REFERENCE DOCUMENTS

The following documents were supplied to the ECMS team as background information:

1. *Initial Proposal Submission, ECM-01: Boiler Plant Decentralization*; NORESCO, September 25, 2007. NORESCO, an energy service company, provides an Initial Proposal analyzing the replacement of the central steam plant with local boilers in buildings.
2. *Los Alamos National Laboratory Steam Plant Project Report*; Bechtel National Inc., Frederick, MD; September 29, 2009. Bechtel, a partner in the M&O for LANL, examines the power, heating and cooling needs of the Laboratory and suggests the combined-cycle CHP proposal currently under consideration; report includes cost and performance information.
3. *Steam Plant Replacement Feasibility Analysis Summary and Supporting Documents*; Strategic Management Solutions, LLC (SMSI); January 17, 2014. SMSI, a subcontractor to LANL, provides a report and series of supporting spreadsheets that examines the thermodynamic performance and resulting financial outcomes for a combined-cycle CHP plant; portions of the spreadsheets are active and may be used to test various cost escalation assumptions.
4. *Comparison of CHP Plant vs. Decentralized Boilers*; LANS U&I Division; April 14, 2014. Initial response to request for the Los Alamos Field Office for a comparative analysis of the local boiler option that succeeded at Sandia National Laboratory.
5. *Los Alamos National Laboratory TA-3 Steam Plant Replacement Analysis of Alternatives*; LANL Utilities and Institutional Facilities Division; July 10, 2014. In response to the request of the Los Alamos Field Office for a more formal analysis, LANL presents an analysis of the most feasible alternatives.
6. *Comparison of Air Quality Permitting Impact of New CHP Plant vs. Local Boilers*; Joe Klose, LANL Sustainability Program; March 18, 2015. A response to Los Alamos Field Office for a description of the air discharge permitting implications of the two leading alternatives.
7. *Comparison of CO2 Emissions and Water Consumption of New CHP Plant vs. Local Boilers*; Joe Klose, LANL Sustainability Program; March 27, 2015. A response to Los Alamos Field Office for a description of the CO2 emissions and water consumption implications of the two leading alternatives.
8. *History of Alternatives Analyzed and the Decisions Made in Proposing the CHP Plant Replacement at LANL*; LANL Infrastructure and Utilities Division; November 23, 2015. A brief history of the series of events and analyses that led to the current CHP recommendation from LANL.

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APPENDIX B: SPA BCA TEAM MEMBERS

The SPA BCA team included the following personnel:

Thomas Robinson	NA-522
Jessica Arcidiacono	NA-533
Tony Trujillo	NA-APM-20
Stephen Fong	NA-LA
Andrew Erickson	LANL Utilities & Infrastructure Division Office (UI-DO)
Joseph Klose	LANL UI-DO
Monica Witt	LANL UI-DO
Sonia Ballesteros	LANL UI-DO
Terry Singell	LANL Principal Associate Directorate Weapons Program
Karen Borovina	LANL Project Management
LeRoy Hasenack	LANL Project Management
Dennis Basile	SMSi
Matt Champagney	Parsons
Ben Butler	Parsons
Mike Lassiter	Longenecker & Associates
Mark Sollenberger	Longenecker & Associates

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APPENDIX C: RISK REGISTER

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			Probability of Occurrence			Consequence			Composite Risk Ranking				
ID	Title	Risk Description	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Notes/Comments	Mitigation Strategies
1	Site and Facilities "As-Found" Conditions	When working around existing physical systems and/or facilities in a 60+ year old federal installation, as-built and as-found conditions are often times different than anticipated. "As-Built" design data, drawings, specs, operating information is lacking. The potential exists for inadvertently contacting existing live utility systems.	1 Very Low	4 High	4 High	2 Marginal	3 Significant	3 Significant	Very Low	Moderate	Moderate	"Do Nothing" case assumes minimal subsurface work inside existing plant area. Consequences vary by entity performing work and impact on contracted schedules - Site Maintenance vs. contracted construction. Probability significantly higher if distribution systems work scopes are eventually justified and included. (Note that Risk # 1, Risk # 7 and Risk # 8 are related but distinct in the following manner. Risk # 1 deals with unknown system configurations. Risk # 2 deals with congested utilities and Risk # 8 touches on potential uncharacterized chemical and/or radiological contaminants that might be encountered)	At approximately 50% design completion, when specific site work scopes are defined, perform extensive field verification of "as-built" conditions.
2	DOE Site vs. Standard Commercial/industrial requirements.	Executing a project on a DOE/NNSA site is difficult and requires more rigor when compared with many commercial and industrial projects. There are numerous requirements and organizations to coordinate with.	N/A	4 High	4 High	N/A	2 Marginal	2 Marginal	N/A	Moderate	Moderate	ESPC/ESCOs are, by definition, familiar with operating on federal/SOE sites. Those that actually have will be more so that those that haven't. Under the LI/D-B case, the assumption is that contractor familiarity with the LANL site operating requirements would be evaluated during eh contractors selection process. If this is NOT the case, this risk becomes more adverse for the LI/D-B acquisition approach case than the ESPC/ESCO strategy.	Assure full-time site coordination support and facilitation of subcontractors by LANL Design, Contracts, Safety and Construction Management organizations.
3	Funding and Subcontractor Support	Inadequate funding and/or support for LANL management, engineering, and oversight staff to support the subcontractors is not sufficient or timely and affects project schedule and/or compliant completion of work.	N/A	3 Moderate	3 Moderate	N/A	3 Significant	2 Marginal	N/A	Moderate	Low	Line Item execution takes place a significant number of years after the ESPC execution. Existing operating systems will have further degraded and the likelihood and consequence of failure will be further elevated.	Assure that the commitment of funding and personnel to provide timely and thorough support of the subcontractor is identified clearly and endorsed at all levels of the department during project development.
4	Timeliness of Decisions	The processes and procedures involved in securing approvals at and during the Critical Decision (CD) gates as prescribed by DOE 413.3 involve an extensive number of personnel and organizational interfaces at all levels of the federal department (DOE). These complexities could extend and/or delay the development and execution of the project completion	N/A	4 High	N/A	N/A	3 Significant	N/A	N/A	Moderate	N/A	LI Invokes full 413.3 requirements. ESPC is not subject to 413.3 requirements except in extreme cases, but even then the requirements are heavily tailored.	----------
5	System Failure	The existing steam facilities, systems, and structures have exceeded their respective design lives. Key existing components of the existing system are no longer in production and/or available for purchase. Selected control system technology and software no longer supported by the original manufacturers. These all pose a risk of system and utilities failure. The risks here are comprised of risk of failure to mission as well as risk to project if either the LI or ESPC options are selected.	4 High	4 High	3 Moderate	4 Critical	4 Critical	2 Marginal	High	High	Low	Probabilities: The "Do Nothing" case is inevitably high and will continue to be, subject to the level of maintenance and system component replacement provided. The ESPC/LI cases are affected by the near-term (4-5 years) versus the long-term (10-12 years) completions schedules. Consequences: "Do Nothing" driven by long-term risk to mission; LI driven by reduced risk to mission but increased risk to project; ESPC driven by reduced risk to mission and reduced risk to project...ESCO incentivizes to recover quickly to schedule interruptions. At the end of the LI and/or ESPC project completions schedules, this risk is minimized for the duration of the design lives of the facilities/systems.	Enhance the MIE and GPP budgets to address major system vulnerabilities early. Accelerate the provision of Line Item funding.
6	Code of Record	The invocation of requirements beyond commercial/industrial codes and standards for the design, procurement, installation, testing, startup, commissioning and turnover of the new facilities will delay the completion of the project and result in potential budget/cost overruns.	N/A	4 High	3 Moderate	N/A	3 Significant	1 Negligible	N/A	Moderate	Very Low	The potential exist to "bubble out" the main plant site work and engage the ESCO in an operations and maintenance (O&M) contract through the term of the ESPC contract. Given this option/potential, the opportunity to design and construct to mostly commercial codes and standards is available.	----------
7	Congested Utilities Routing	The re-routing of utilities (water, feed water, power, NG, controls, etc.) within the established steam plant site may be limited and the lack of dependable "as-constructed utility systems data may delay or pose risks for new work. (If the scope of the project later determines that additional distribution systems upgrades/replacement is warranted, from an energy savings and/or reliability perspectives, the highly developed nature of TA-3, further limiting available corridors and space to route utilities, will be an even higher risk)	N/A	3 Moderate	3 Moderate	N/A	3 Significant	2 Marginal	N/A	Moderate	Low	Devoid of alternate work plans and options for effective labor utilization during construction, significant schedule slip may be experienced under FFP/D-B scenarios. (LI & ESPC).(Note that Risk # 1, Risk # 7 and Risk # 8 are related but distinct in the following manner. Risk # 1 deals with unknown system configurations. Risk # 2 deals with congested utilities and Risk # 8 touches on potential uncharacterized chemical and/or radiological contaminants that might be encountered)	Potholing and surveying, coupled with an aggressive utility as-building effort should be pursued during design to confirm minimize interferences.
8	Latent Subsurface Conditions	Unknown subsurface conditions including chemical and radiological contamination exist at the LANL site and are frequently discovered after construction has started. The potential for encountering these conditions is not insignificant.	3 Moderate	3 Moderate	3 Moderate	2 Marginal	3 Significant	3 Significant	Low	Moderate	Moderate	Devoid of alternate work plans and options for effective labor utilization during construction, significant schedule slip may be experienced under FFP/D-B scenarios. (Note that Risk # 1, Risk # 7 and Risk # 8 are related but distinct in the following manner. Risk # 1 deals with unknown system configurations. Risk # 2 deals with congested utilities and Risk # 8 touches on potential uncharacterized chemical and/or radiological contaminants that might be encountered)	At approximately 50% design completion, when specific site work scopes are defined, perform extensive field verification of subsurface contaminant characterizations.
9	Technical Expertise in Supporting Major Utility Upgrades	LANL does not routinely engage in power plant construction and the ability to secure technical assistance in plant component design review, inspection, and estimating may be limiting.	N/A	3 Moderate	3 Moderate	N/A	3 Significant	3 Significant	N/A	Moderate	Moderate	ESPC ESCOs have been pre-qualified with this expertise being part of their qualifications. Under the LI scenario, a general construction contractor may be the "preferred" bidder, but not have these capabilities	Assure that the selection criteria for a general contractor under the Line Item scenario includes and highly values historic demonstration of and proficiency in the design and installation of similar power/steam systems.

			Probability of Occurrence			Consequence			Composite Risk Ranking				
ID	Title	Risk Description	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Notes/Comments	Mitigation Strategies
10	Steam Distribution System: Aging Failures	The plant is intended to be in service for 30 years and, if the projects do not propose to replace existing steam pipe between manholes and/or repair and replace other distribution system components (traps, manholes, etc.), this implies that these components would remain in service for a century and the risk of failure increases aggressively over time.	5 Very High	5 Very High	5 Very High	1 Negligible	3 Significant	2 Marginal	Low	High	Moderate	On-site Maintenance can respond as system failures become evident over time. ESPC/ESCO Line Item GC could mitigate this risk in the 2030 time frame.	Consider enhancing the plant maintenance and repair budgets (expense and GPP) in the near-term to affect these modifications.
11	Introducing Experimental Technologies	The potential exists to consider having this LANL project serve as a demonstration site for utility-scale, super critical CO2 power cycle. The risk associated with tying a demonstration technology to an expansive central utility plant upgrade/retrofit could potentially compromise project execution schedules and the ability to meet mission requirements.	N/A	3 Moderate	3 Moderate	N/A	2 Marginal	3 Significant	N/A	Low	Moderate	The consequence difference is driven by the near-term nature of the ESPC acquisition scenario and the financial incentive for the ESPC to complete and bring the project on line early or on time.	Assure that the prototype technology has minimal technical and operational uncertainties and can demonstrate proven reliable applications in industry prior to incorporation into the scope of either of the two full-scope acquisition strategies.
12	Air Permit Mods	If the final design of the new facilities results in emission analyses that conclude that actions other than a minor modification (reduction) to the current permit is required, significant schedule delays in execution will exist.	N/A	2 Low	2 Low	N/A	3 Significant	2 Marginal	N/A	Low	Very Low	The delta is a product of the execution timeframes of the acquisition approaches and the aging facilities considerations.	----------
13	SWEIS & Water Consumption	If the final design of the new facilities results in water utilization analyses that conclude that actions conflict with the existing SWEIS, schedule delays will be realized.	N/A	2 Low	2 Low	N/A	3 Significant	2 Marginal	N/A	Low	Very Low	The delta is a product of the execution timeframes of the acquisition approaches and the aging facilities considerations.	----------
14	Gas Pipeline Allocation	LANL is an allocated user of the SW pipeline distribution system. If the final configuration of the designed improvements challenges the capacity of that allotment, the projects and the corresponding objectives may be jeopardized.	1 Very Low	1 Very Low	1 Very Low	1 Negligible	1 Negligible	1 Negligible	Very Low	Very Low	Very Low	There is little suspicion from the site personnel that this risk will be a prominent and/or significant factor in any of the scenarios considered.	----------
15	Analysis and confirmation of estimates	LANL does not have in-house resources to perform estimate analysis and confirmation, which is vital in negotiation major Design and Construction subcontracts. The inability to secure the audit-level cost estimating analytic services/expertise could delay decision making and initializing work on the utilities improvements...thus compromising project completion.	N/A	3 Moderate	3 Moderate	N/A	2 Marginal	3 Significant	N/A	Low	Moderate	The time imperative for securing these expertise and services is most severe with the ESPC acquisition case, which could be initiated within this calendar year.	Make the acquisition decision immediately and promptly secure subcontracts to provide these objective, support analytic services.
16	Cost of Fuels & Regulatory Uncertainties	Although it is likely that the site will benefit from low NG prices in the 10 year timeframe, there are uncertainties stemming from the future regulation of fossil fuel as a result of climate change. Direct fuel costs and purchase of power from fossil-fueled power providers may affect the payback terms of energy savings probability of meeting environmental compliance objectives	3 Moderate	3 Moderate	3 Moderate	2 Marginal	2 Marginal	1 Negligible	Low	Low	Very Low	The effects of energy savings can be directly translatable into the payback terms and conditions of the ESPC...up to and until the ROI becomes calculably unfeasible.	----------
17	Executive Order 436.1: Greenhouse gas emissions and Carbon Foot Print Compliance	Compliance with Executive Order 436.1 (signed March 19, 2015) must be achieved by 2025. The execution and acquisition options chosen may jeopardize meeting this compliance objective,	5 Very High	5 Very High	1 Very Low	3 Significant	3 Significant	1 Negligible	High	High	Very Low	The "Do Nothing" strategy affords no chance, technically for meeting the compliance objectives. The Line Item Strategy affords no chance, time-wise, for meeting the compliance objectives.	DOE provide adequate capital funding starting in 2017 to complete the project under Line Item execution guidelines.
18	Negotiating an Operating Agreement	Under both the Line Item and ESPC acquisition scenarios there are many decisions yet to be addressed in support of the concept of contracting to simply design and build the proposed facilities vs. long-term maintenance and operations operating of the plant subsequent to completions vs. contracting for power and steam at a predetermined price. Failure to secure prompt and timely endorsement of these decisions/strategies could affect the efficiency of short-term execution and long-term return on investment (primarily for the ESPC case.	N/A	3 Moderate	3 Moderate	N/A	2 Marginal	3 Significant	N/A	Low	Moderate	The consequence is most severe in the ESPC scenario considering the near-term efforts of the ESPC strategy and have a higher impact on contract terms and conditions, ROI and M&V positions over the term of this agreement.	Discuss, analyze, decide and secure endorsements for these considerations immediately and incorporate the results of these decisions into the acquisition strategy.
19	Change Order Delays	Delays in expediently processing change orders (which will unquestionably occur) will delay decision making and compromise meeting the objectives of the projects and corresponding mission needs. (Challenges were experienced during the execution of a prior ESPC)	N/A	3 Moderate	3 Moderate	N/A	2 Marginal	3 Significant	N/A	Low	Moderate	There is financial incentive for the ESCO to complete the project and cause it to be operational on or ahead of schedule...driven by cost savings reimbursement schedules committed under contract and monitored by the ESCO management and stakeholders.	Explicitly define the change order processing protocols, timeframes and roles and responsibilities of all parties involved in the in the RFP and the final contract T&Cs.
20	Seasonal Construction Windows	System outages and tie ins to both the central plant and the distribution system may affect the timeframe for executing and completing the work.	N/A	2 Low	2 Low	N/A	2 Marginal	2 Marginal	N/A	Very Low	Very Low	Line Item Scenario - Negotiated change Order. ESPC scenario - Negotiated change order and contract payback terms.	----------
21	O&M support of demolition, construction, startup and turnover.	The air-gapping, outages and/or relocation of utilities and systems interfacing with the new plant installations, by site O&M forces, could affect the project completion schedule.	N/A	2 Low	2 Low	N/A	2 Marginal	3 Significant	N/A	Very Low	Low	The ESPC scenario is elevated in that there is financial incentive for the ESCO to complete the project and cause it to be operational on or ahead of schedule...driven by cost savings reimbursement schedules committed under contract and monitored by the ESCO management and stakeholders.	----------
22	Safety: Stop Work (i.e. @ other facilities, @ our facility)	A local (LANL) and/or DOE-complex-wide stand down of a work activity could affect project completion. (LOTO, hoisting and rigging, hot work, trenching, elevated work, etc.)	2 Low	2 Low	2 Low	1 Negligible	2 Marginal	3 Significant	Very Low	Very Low	Low	The ESPC scenario is elevated in that there is financial incentive for the ESCO to complete the project and cause it to be operational on or ahead of schedule...driven by cost savings reimbursement schedules committed under contract and monitored by the ESCO management and stakeholders.	----------
23	Training	Training of personnel for integrated process operations, maintenance and repair of the new systems will not be defined, supported, documented, proceduralized and validated supportive of the testing, startup and commissioning of the project schedule.	N/A	3 Moderate	3 Moderate	N/A	2 Marginal	3 Significant	N/A	Low	Moderate	This is a joint contractor/LANL effort. The inability to secure the resources necessary to develop and integrate these processes into the plant O&M systems will affect the completion and turnover schedules (the application and affects of this risk are subject to the discussion in risk Item # 17). Consequence differences are related to the ESCO incentive to meet and or exceed project completion schedules due to energy saving reimbursement terms.	Expedite the decisions covered in Risk Item # 17 and clearly define the associated O&M processes and procedures that will need to be developed to support those decisions. Assure that they are clearly defined in the ESPC contracts.
24	Long-Lead and/or Delayed Procurements	Long-Lead major equipment procurements and or delays in deliveries of this major equipment items may drive the completion dates for the projects.	N/A	2 Low	2 Low	N/A	2 Marginal	3 Significant	N/A	Very Low	Low	The main consequence driver here is the financial incentive that the ESCO has in completing the project on or ahead of schedule	----------

			Probability of Occurrence			Consequence			Composite Risk Ranking				
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25	"Island Mode" Operation	The ability to cost-effectively feed the laboratory the power systems in "Island" mode, coupled with a reliable and efficient steam supply system may be compromised depending on the option selected and the timing of executing that option.	N/A	4 High	2 Low	N/A	3 Significant	1 Negligible	N/A	Moderate	Very Low	The "Do Nothing" scenarios does not involve the long-term generation of power from existing systems under an island operating condition. The LI and ESPC/ESCO considerations are primarily driven by the duration of execution.	----------
26	Steam/Condensate Loss Assumptions	If steam or condensate losses exceed those assumed in the energy calculations, commodity costs (water and gas) would increase and thus erode the assumed savings of the CHP plant.	3 Moderate	3 Moderate	3 Moderate	1 Negligible	1 Negligible	2 Marginal	Very Low	Very Low	Low	The actual measured losses will most certainly be different than those estimated to date. The only case that will be affected by this consideration will be the ESPC/ESCO case in that the energy saving calculations will be derived based on this being a factor. Nevertheless, these losses are perceived to be minor in the total energy savings calculations and in-turn the payback of the investment.	----------
						Composite totals			56	206	157		
						Occurrences			9	26	25		
						Case Average			6.2	7.9	6.3		
									Do Nothing	Do Work			

			Probability of Occurrence			Consequence			Composite Risk Ranking				
ID	Title	Risk Description	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Do Nothing (O&M Investments)	Full Scope LI	Full Scope ESPC	Notes/Comments	Mitigation Strategies
1	Site and Facilities "As-Found" Conditions	When working around existing physical systems and/or facilities in a 60+ year old federal installation, as-built and as-found conditions are often times different than anticipated. "As-Built" design data, drawings, specs, operating information is lacking. The potential exists for inadvertently contacting existing live utility systems.	1	4	4	2	3	3	2	12	12	"Do Nothing" case assumes minimal subsurface work inside existing plant area. Consequences vary by entity performing work and impact on contracted schedules - Site Maintenance vs. contracted construction. Probability significantly higher if distribution systems work scopes are eventually justified and included. (Note that Risk # 1, Risk # 7 and Risk # 8 are related but distinct in the following manner. Risk # 1 deals with unknown system configurations. Risk # 2 deals with congested utilities and Risk # 8 touches on potential uncharacterized chemical and/or radiological contaminants that might be encountered)	At approximately 50% design completion, when specific site work scopes are defined, perform extensive field verification of "as-built" conditions.
2	DOE Site vs. Standard Commercial/industrial requirements.	Executing a project on a DOE/NNSA site is difficult and requires more rigor when compared with many commercial and industrial projects. There are numerous requirements and organizations to coordinate with.	N/A	4	4	N/A	2	2	N/A	8	8	ESPC/ESCOs are, by definition, familiar with operating on federal/SOE sites. Those that actually have will be more so that those that haven't. Under the LI/D-B case, the assumption is that contractor familiarity with the LANL site operating requirements would be evaluated during eh contractors selection process. If this is NOT the case, this risk becomes more adverse for the LI/D-B acquisition approach case than the ESPC/ESCO strategy.	Assure full-time site coordination **support** and facilitation of subcontractors by LANL Design, Contracts, Safety and Construction Management organizations.
3	Funding and Subcontractor Support	Inadequate funding and/or support for LANL management, engineering, and oversight staff to support the subcontractors is not sufficient or timely and affects project schedule and/or compliant completion of work.	N/A	3	3	N/A	3	2	N/A	9	6	Line Item execution takes place a significant number of years after the ESPC execution. Existing operating systems will have further degraded and the likelihood and consequence of failure will be further elevated.	Assure that the commitment of funding and personnel to provide timely and thorough support of the subcontractor is identified clearly and endorsed at all levels of the department during project development.
4	Timeliness of Decisions	The processes and procedures involved in securing approvals at and during the Critical Decision (CD) gates as prescribed by DOE 413.3 involve an extensive number of personnel and organizational interfaces at all levels of the federal department (DOE). These complexities could extend and/or delay the development and execution of the project completion	N/A	4	N/A	N/A	3	N/A	N/A	12	N/A	LI Invokes full 413.3 requirements. ESPC is not subject to 413.3 requirements except in extreme cases, but even then the requirements are heavily tailored.	---------
5	System Failure	The existing steam facilities, systems, and structures have exceeded their respective design lives. Key existing components of the existing system are no longer in production and/or available for purchase. Selected control system technology and software no longer supported by the original manufacturers. These all pose a risk of system and utilities failure. The risks here are comprised of risk of failure to mission as well as risk to project if either the LI or ESPC options are selected.	4	4	3	4	4	2	16	16	6	Probabilities: The "Do Nothing" case is inevitably high and will continue to be, subject to the level of maintenance and system component replacement provided. The ESPC/LI cases are affected by the near-term (4-5 years) versus the long-term (10-12 years) completions schedules. Consequences: "Do Nothing" driven by long-term risk to mission; LI driven by reduced risk to mission but increased risk to project; ESPC driven by reduced risk to mission and reduced risk to project...ESCO incentivizes to recover quickly to schedule interruptions. At the end of the LI and/or ESPC project completions schedules, this risk is minimized for the duration of the design lives of the facilities/systems.	Enhance the MIE and GPP budgets to address major system vulnerabilities early. Accelerate the provision of Line Item funding.
6	Code of Record	The invocation of requirements beyond commercial/industrial codes and standards for the design, procurement, installation, testing, startup, commissioning and turnover of the new facilities will delay the completion of the project and result in potential budget/cost overruns.	N/A	4	3	N/A	3	1	N/A	12	3	The potential exist to "bubble out" the main plant site work and engage the ESCO in an operations and maintenance (O&M) contract through the term of the ESPC contract. Given this option/potential, the opportunity to design and construct to mostly commercial codes and standards is available.	---------
7	Congested Utilities Routing	The re-routing of utilities (water, feed water, power, NG, controls, etc.) within the established steam plant site may be limited and the lack of dependable "as-constructed utility systems data may delay or pose risks for new work. (If the scope of the project later determines that additional distribution systems upgrades/replacement is warranted, from an energy savings and/or reliability perspectives, the highly developed nature of TA-3, further limiting available corridors and space to route utilities, will be an even higher risk)	N/A	3	3	N/A	3	2	N/A	9	6	Devoid of alternate work plans and options for effective labor utilization during construction, significant schedule slip may be experienced under FFP/D-B scenarios. (LI & ESPC).(Note that Risk # 1, Risk # 7 and Risk # 8 are related but distinct in the following manner. Risk # 1 deals with unknown system configurations. Risk # 2 deals with congested utilities and Risk # 8 touches on potential uncharacterized chemical and/or radiological contaminants that might be encountered)	Potholing and surveying, coupled with an aggressive utility as-building effort should be pursued during design to confirm minimize interferences.
8	Latent Subsurface Conditions	Unknown subsurface conditions including chemical and radiological contamination exist at the LANL site and are frequently discovered after construction has started. The potential for encountering these conditions is not insignificant.	3	3	3	2	3	3	6	9	9	Devoid of alternate work plans and options for effective labor utilization during construction, significant schedule slip may be experienced under FFP/D-B scenarios. (Note that Risk # 1, Risk # 7 and Risk # 8 are related but distinct in the following manner. Risk # 1 deals with unknown system configurations. Risk # 2 deals with congested utilities and Risk # 8 touches on potential uncharacterized chemical and/or radiological contaminants that might be encountered)	At approximately 50% design completion, when specific site work scopes are defined, perform extensive field verification of subsurface contaminant characterizations.
9	Technical Expertise in Supporting Major Utility Upgrades	LANL does not routinely engage in power plant construction and the ability to secure technical assistance in plant component design review, inspection, and estimating may be limiting.	N/A	3	3	N/A	3	3	N/A	9	9	ESPC ESCOs have been pre-qualified with this expertise being part of their qualifications. Under the LI scenario, a general construction contractor may be the "preferred" bidder, but not have these capabilities	Assure that the selection criteria for a general contractor under the Line Item scenario includes and highly values historic demonstration of and proficiency in the design and installation of similar power/steam systems.
10	Steam Distribution System: Aging Failures	The plant is intended to be in service for 30 years and, <u>if</u> the projects do not propose to replace existing steam pipe between manholes and/or repair and replace other distribution system components (traps, manholes, etc.), this implies that these components would remain in service for a century and the risk of failure increases aggressively over time.	5	5	5	1	3	2	5	15	10	On-site Maintenance can respond as system failures become evident over time. ESPC/ESCO Line Item GC could mitigate this risk in the 2030 timeframe.	Consider enhancing the plant maintenance and repair budgets (expense and GPP) in the near-term to affect these modifications.

11	Introducing Experimental Technologies	The potential exists to consider having this LANL project serve as a demonstration site for utility-scale, super critical CO2 power cycle. The risk associated with tying a demonstration technology to an expansive central utility plant upgrade/retrofit could potentially compromise project execution schedules and the ability to meet mission requirements.	N/A	3	3	N/A	2	3	N/A	6	9	The consequence difference is driven by the near-term nature of the ESPC acquisition scenario and the financial incentive for the ESPC to complete and bring the project on line early or on time.	Assure that the prototype technology has minimal technical and operational uncertainties and can demonstrate proven reliable applications in industry prior to incorporation into the scope of either of the two full-scope acquisition strategies.
12	Air Permit Mods	If the final design of the new facilities results in emission analyses that conclude that actions other than a minor modification (reduction) to the current permit is required, significant schedule delays in execution will exist.	N/A	2	2	N/A	3	2	N/A	6	4	The delta is a product of the execution timeframes of the acquisition approaches and the aging facilities considerations.	--------
13	SWEIS & Water Consumption	If the final design of the new facilities results in water utilization analyses that conclude that actions conflict with the existing SWEIS, schedule delays will be realized.	N/A	2	2	N/A	3	2	N/A	6	4	The delta is a product of the execution timeframes of the acquisition approaches and the aging facilities considerations.	--------
14	Gas Pipeline Allocation	LANL is an allocated user of the SW pipeline distribution system. If the final configuration of the designed improvements challenges the capacity of that allotment, the projects and the corresponding objectives may be jeopardized.	1	1	1	1	1	1	1	1	1	There is little suspicion from the site personnel that this risk will be a prominent and/or significant factor in any of the scenarios considered.	--------
15	Analysis and confirmation of estimates	LANL does not have in-house resources to perform estimate analysis and confirmation, which is vital in negotiation major Design and Construction subcontracts. The inability to secure the audit-level cost estimating analytic services/expertise could delay decision making and initializing work on the utilities improvements...thus compromising project completion.	N/A	3	3	N/A	2	3	N/A	6	9	The time imperative for securing these expertise and services is most severe with the ESPC acquisition case, which could be initiated within this calendar year.	Make the acquisition decision immediately and promptly secure subcontracts to provide these objective, support analytic services.
16	Cost of Fuels & Regulatory Uncertainties	Although it is likely that the site will benefit from low NG prices in the 10 year timeframe, there are uncertainties stemming from the future regulation of fossil fuel as a result of climate change. Direct fuel costs and purchase of power from fossil-fueled power providers may affect the payback terms of energy savings probability of meeting environmental compliance objectives	3	3	3	2	2	1	6	6	3	The effects of energy savings can be directly translatable into the payback terms and conditions of the ESPC...up to and until the ROI becomes calculably unfeasible.	--------
17	Executive Order 436.1: Greenhouse gas emissions and Carbon Foot Print Compliance	Compliance with Executive Order 436.1 (signed March 19, 2015) must be achieved by 2025. The execution and acquisition options chosen may jeopardize meeting this compliance objective,	5	5	1	3	3	1	15	15	1	The "Do Nothing" strategy affords no chance, technically for meeting the compliance objectives. The Line Item Strategy affords no chance, time-wise, for meeting the compliance objectives	DOE provide adequate capital funding starting in 2017 to complete the project under Line Item execution guidelines
18	Negotiating an Operating Agreement	Under both the Line Item and ESPC acquisition scenarios there are many decisions yet to be addressed in support of the concept of contracting to simply design and build the proposed facilities vs. long-term maintenance and operations operating of the plant subsequent to completions vs. contracting for power and steam at a predetermined price. Failure to secure prompt and timely endorsement of these decisions/strategies could affect the efficiency of short-term execution and long-term return on investment (primarily for the ESPC case.	N/A	3	3	N/A	2	3	N/A	6	9	The consequence is most severe in the ESPC scenario considering the near-term efforts of the ESPC strategy and have a higher impact on contract terms and conditions, ROI and M&V positions over the term of this agreement.	Discuss, analyze, decide and secure endorsements for these considerations immediately and incorporate the results of these decisions into the acquisition strategy.
19	Change Order Delays	Delays in expediently processing change orders (which will unquestionably occur) will delay decision making and compromise meeting the objectives of the projects and corresponding mission needs. (Challenges were experienced during the execution of a prior ESPC)	N/A	3	3	N/A	2	3	N/A	6	9	There is financial incentive for the ESCO to complete the project and cause it to be operational on or ahead of schedule...driven by cost savings reimbursement schedules committed under contract and monitored by the ESCO management and stakeholders.	Explicitly define the change order processing protocols, timeframes and roles and responsibilities of all parties involved in the in the RFP and the final contract T&Cs.
20	Seasonal Construction Windows	System outages and tie ins to both the central plant and the distribution system may affect the timeframe for executing and completing the work.	N/A	2	2	N/A	2	2	N/A	4	4	Line Item Scenario - Negotiated change Order. ESPC scenario - Negotiated change order and contract payback terms.	--------
21	O&M support of demolition, construction, startup and turnover.	The air-gapping, outages and/or relocation of utilities and systems interfacing with the new plant installations, by site O&M forces, could affect the project completion schedule.	N/A	2	2	N/A	2	3	N/A	4	6	The ESPC scenario is elevated in that there is financial incentive for the ESCO to complete the project and cause it to be operational on or ahead of schedule...driven by cost savings reimbursement schedules committed under contract and monitored by the ESCO management and stakeholders.	--------

22	Safety: Stop Work (i.e. @ other facilities, @ our facility)	A local (LANL) and/or DOE-complex-wide stand down of a work activity could affect project completion. (LOTO, hoisting and rigging, hot work, trenching, elevated work, etc.)	2	2	2	1	2	3	2	4	6	The ESPC scenario is elevated in that there is financial incentive for the ESCO to complete the project and cause it to be operational on or ahead of schedule...driven by cost savings reimbursement schedules committed under contract and monitored by the ESCO management and stakeholders.	--------
23	Training	Training of personnel for integrated process operations, maintenance and repair of the new systems will not be defined, supported, documented, proceduralized and validated supportive of the testing, startup and commissioning of the project schedule.	N/A	3	3	N/A	2	3	N/A	6	9	This is a joint contractor/LANL effort. The inability to secure the resources necessary to develop and integrate these processes into the plant O&M systems will affect the completion and turnover schedules (the application and affects of this risk are subject to the discussion in risk Item # 17). Consequence differences are related to the ESCO incentive to meet and or exceed project completion schedules due to energy saving reimbursement terms.	Expedite the decisions covered in Risk Item # 17 and clearly define the associated O&M processes and procedures that will need to be developed to support those decisions. Assure that they are clearly defined in the ESPC contracts.
24	Long-Lead and/or Delayed Procurements	Long-Lead major equipment procurements and or delays in deliveries of this major equipment items may drive the completion dates for the projects.	N/A	2	2	N/A	2	3	N/A	4	6	The main consequence driver here is the financial incentive that the ESCO has in completing the project on or ahead of schedule	--------
25	"Island Mode" Operation	The ability to cost-effectively feed the laboratory the power systems in "Island" mode, coupled with a reliable and efficient steam supply system may be compromised depending on the option selected and the timing of executing that option.	N/A	4	2	N/A	3	1	N/A	12	2	The "Do Nothing" scenarios does not involve the long-term generation of power from existing systems under an island operating condition. The LI and ESPC/ESCO considerations are primarily driven by the duration of execution.	--------
26	Steam/Condensate Loss Assumptions	If steam or condensate losses exceed those assumed in the energy calculations, commodity costs (water and gas) would increase and thus erode the assumed savings of the CHP plant.	3	3	3	1	1	2	3	3	6	The actual measured losses will most certainly be different than those estimated to date. The only case that will be affected by this consideration will be the ESPC/ESCO case in that the energy saving calculations will be derived based on this being a factor. Nevertheless, these losses are perceived to be minor in the total energy savings calculations and in-turn the payback of the investment.	--------
						Composite totals			56	206	157		
						Occurrences			9	26	25		
						Case Average			6.2	7.9	6.3		
									Do Nothing	Do Work			