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Nuclear Legacy Liability Program (NLLP) Prioritization

Risk-based prioritization of the environmental remediation and facility decommissioning projects at the Chalk River Laboratory in Ontario, Canada

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Project Objectives

- Develop an objective, risk-based, defensible, and repeatable process and basis for the prioritization and ranking of the projects in the NLLP
- Prioritize the environmental remediation and facility decommissioning projects in the NLLP at the Chalk River Laboratory (CRL)

Portfolio Prioritization and Sequencing

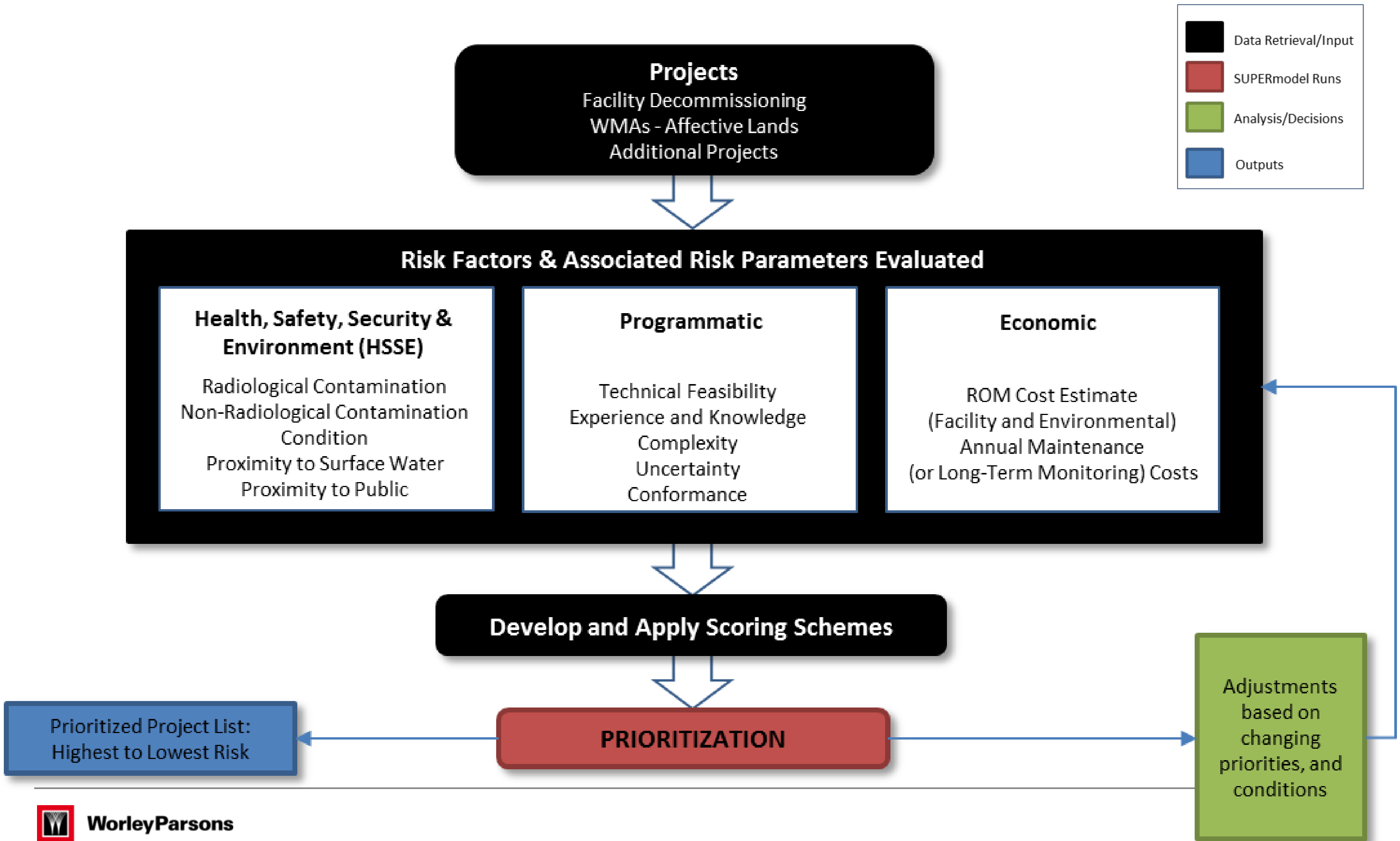
- Process performed previously and for massive legacy liability site portfolios:
  - Savannah River Site (SRS)
    - 1,013 facility decommissioning projects
    - 253 environmental remediation projects
    - Existing operations
    - Liability: $4-5B (USD), 22 years
  - Y-12 Security Complex & Oak Ridge National Laboratory
    - 440 facility decommissioning projects
    - 320 environmental restoration projects
    - 16 Capital, modernization, construction, and reconfiguration projects
    - Liability: $4-8B (USD), 40 years

Background: Terminology / Definitions

- Prioritization: ranking projects from highest to lowest composite risk
- Sequencing: optimizing the project schedule based on constraints (e.g. milestones, budget, durations, etc.)
- Risks: Current presence of hazards and/or conditions
- Risk Parameters: Matrices with criteria that reflect increasing or decreasing presence of hazards, conditions, or unknowns which reflect changes in risk
- Risk Factors: Categorized risk parameters
  - Health, Safety, Security, and Environment (HSSE)
  - Programmatic
  - Economic

- Scoring Schemes: Combination of weighted risk factors that allows additional emphasis to be placed on selected risk factors

Sequencing Unit Prioritization Estimating Risk Model (SUPERmodel) - Prioritization Process



Core Project Data

- Gathered/obtained minimum core project data required for prioritization
  - Project # & Name
  - Project Type
  - Square footage
  - Area
  - Year built/created
  - Status
  - Endstate
  - Radiological/non-radiological
  - Liquids/solids
  - Waste volumes
- Used data to assist in initial (i.e. default) risk value determinations
- Project data used in parametric rough order-of-magnitude (ROM) cost estimating models for both environmental remediation and facility decommissioning projects

Project Categorization

- Projects organized into Planning Envelopes (PEs), consistent with the Comprehensive Preliminary Decommissioning Plan
- Total of 369 projects
  - 275 Facility Decommissioning projects
    - PE1: Nuclear Facilities (59)
    - PE2: Radiochemical Laboratories (36)
    - PE3: Low Hazard Contaminated Structures (68)
    - PE4: Non-contaminated Structures (107)
    - PE5: Distributed Services (5)
  - 94 Environmental Remediation Projects
    - PE6: Affected Lands (15)
    - PE7: Waste Management Areas (WMAs) (79)

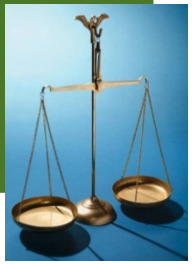
Risk Parameters

- Twelve (12) risk parameters were identified and used:
  - Radiological contamination
  - Non-radiological contamination
  - Proximity to public
  - Proximity to surface water
  - Condition
  - Technical feasibility
  - Experience and knowledge
  - Complexity
  - Uncertainty
  - Conformance
  - ROM cost estimate
  - Annual maintenance costs
    - *% of overall ROM cost when actuals not available*
- Defined with specific criteria and documented through the development of matrices for each risk parameter.

Risk Parameter Matrix: Example

Uncertainty					
Risk Level	Criteria Description	Assigned Value (Risk-Based Prioritization)	Default Values		
			Building/Structure	Environmental Operational Date	Environmental Shutdown Date
Extensive Information Gaps	Very little operations information, historical data, or investigation information exists or is available; no plan to fill the gaps exists, limited to non-routine surveys (radiological and non-radiological hazards) exist; generally, low confidence in the existing information; or > 6 months to address the information gap.	10	PE1, PE2	≥1940	≤1960
Moderate Information Gaps	Some operations information, historical data, or investigation information exists, but information is 'dated' and/or significant information gaps exist; identified need for a plan to address the information gaps; limited data from routine surveys or investigations are available; areas of radiological and non-radiological contamination can not be delineated from existing data. Further investigation and characterization required for waste classification and to identify disposal pathways, personal protection equipment and clothing determinations, or to determine project end-state; or requires 3-6 months to address the information gap.	8		≥1960	≤1980
Partial/Limited Information Gaps	Have most operations information, historical data, and/or investigation information; however, some information gaps may still exist. Characterization plan approved and/or being executed; data from routine surveys are available; areas of radiological and non-radiological contamination are partially delineated and additional sampling is required; further characterization may be required for waste classification and/or identification disposal pathways. Data is recent; or requires 1 to < 3 months to address the information gaps.	5	PE3, PE4	≥1980	≤2005
Minimal Information Gaps	Extensive historical data and/or operations information is available (no gaps), plan to address information gaps in-place and executed/performed; analytical data delineates areas of radiological and non-radiological contamination. No additional sampling required, however further data evaluation is necessary; confidence high; or requires < 1 month to address the information gaps.	2	PE5	≥2005	≤2020
No Information Gaps	No further information required and all analyses have been completed.	1	EF		

Risk Parameter Weightings



- Risk parameter weightings developed with input from stakeholders in alignment workshops
  - Allowed for stakeholder influence in prioritization by risk
  - Accounts for differing views and perspectives of risk
- Prevented arbitrary prioritization of specific projects
- Forced to balance risks at appropriate level
  - Major factors vs. influencers
- Maintained a technically objective evaluation without introducing social bias or additional judgement
  - Supports multi-criteria analysis and risk-based decision-making
  - Social factors are considered during sequencing

Risk Parameter Weightings

- Determined with input from major stakeholder groups

HSSE	Final Weightings
Radiological Contamination	31%
Non-Radiological Contamination	23%
Condition	19%
Proximity to Surface Water	18%
Proximity to Public	9%
TOTAL	100%

Programmatic	Final Weightings
Uncertainty	23%
Conformance	21%
Technical Feasibility	19%
Complexity	19%
Experience & Knowledge	18%
TOTAL	100%

Economic	Final Weightings
Annual Maintenance / Long-Term Monitoring Costs	70%
ROM Estimated Cost	30%
TOTAL	100%

Risk Parameters: Default Values

- Project information is was not always readily available
- Default risk parameter values were developed for each risk parameter matrix
  - Required in order to assign a risk value to each project when little to no information exists or is readily available
- The following data was used to establish defaults risk values:
  - PE
  - Contamination Zone – existing areas of increasing radiological impact
  - Year built/created
  - Location

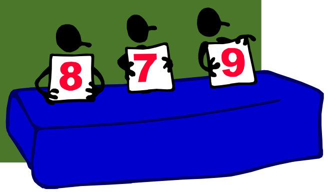
Risk Parameters:
Facility Decommissioning ROM Cost Estimate

- Determined base facility D&D unit cost
  - Escalated previous decommissioning rates to current year rates
- Facility ROM Cost Estimate = Size × Decommissioning Unit Rate × Radiological Contamination × Non-Radiological Contamination × Complexity × Uncertainty × End State × Construction Type * Site Correction Factor
  - *Based on INL Parametric ROM Cost estimating model*

Risk Parameters: Environmental ROM Cost Estimates

- Environmental ROM cost estimates were estimated by an independent third party and used
  - SUPERmodel-generated environmental ROM cost estimates were overridden
- SUPERmodel still calculates ROM cost estimates for environmental remediation projects using selected unit rates for likely remediation methods
  - Environmental ROM Cost = V × U
    - V = volume of contaminated media or installed remediation material (m^3), depending on remediation technology being applied
    - U = remediation method unit cost ($\$/m^3$)
      - Units rates were selected and escalated to 2012 dollars from published unit rates from the Federal Remediation Technology Roundtable (FRTR) and/or U.S. Environmental Protection Agency (EPA)

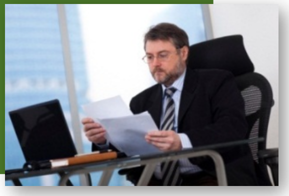
Risk Factors & Scoring Schemes



- Risk factors
  - HSSE = [(R-Cont(w) + NR-Cont(w)) * (ProxP(w) + ProxW(w) + Cond(w))]
  - Programmatic = (TF(w) + E&K(w) + Comp(w) + Unc(w) + Conf(w))
  - Economic = (ROM(w) + MaintCost(w))
    - *(w) = weighting*
- Scoring schemes & weighting

Scoring Scheme	HSSE	Programmatic	Economic
SS1: All Things Being Equal *(Baseline)*	33%	33%	34%
SS2: Safety First	60%	30%	10%
SS3: Program Objectives	10%	60%	30%
SS4: Economic	10%	30%	60%

Sensitivity Study: Results Summary



- Performed sensitivity study on seven (7) representative projects selected by AECL
- Weightings assigned to the risk parameters largely determined the level impact of the risk parameters, which is in-line with the design of the model
- Risk parameters which had the greatest impact to prioritization
  - Annual maintenance cost
  - Radiological contamination
  - ROM cost

Basis for Prioritization

- Prioritization results reflect a highest to lowest relative risk ranking for all projects in the NLLP portfolio
- Utilizes a composite risk score (CRS) to assign a ranking
- Evaluated and compared results of four (4) different scoring schemes
  - 1 baseline, 3 with one risk factor weighted higher than the other two
- Two (2) groups
  - All NLLP projects (70-year plan)
  - All projects currently in the NLLP including those expected to be handed over in the next 10 years
    - Excludes those beyond 10 years

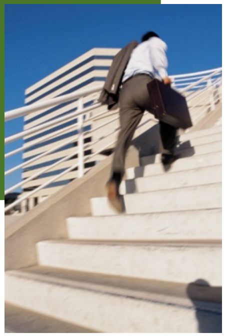
Prioritization: Current Results

- Nuclear facility projects and waste management areas (WMAs) generally trending toward the top of the priority/ranking list
  - Due to higher programmatic risks and opportunities to reduce maintenance costs
  - Specific WMA/Affected lands projects are found in the Top 50
- Non-contaminated structures/projects trend toward the bottom of the list (i.e. lower priority)
- When programmatic risks are weighted higher, more nuclear projects rise to the top projects in affected lands and WMAs move to the bottom (lower priority)
- When HSSE and/or Economic risks are weighted higher, selected projects in PEs 1& 7 dominate the Top 100

Outcomes & Conclusions

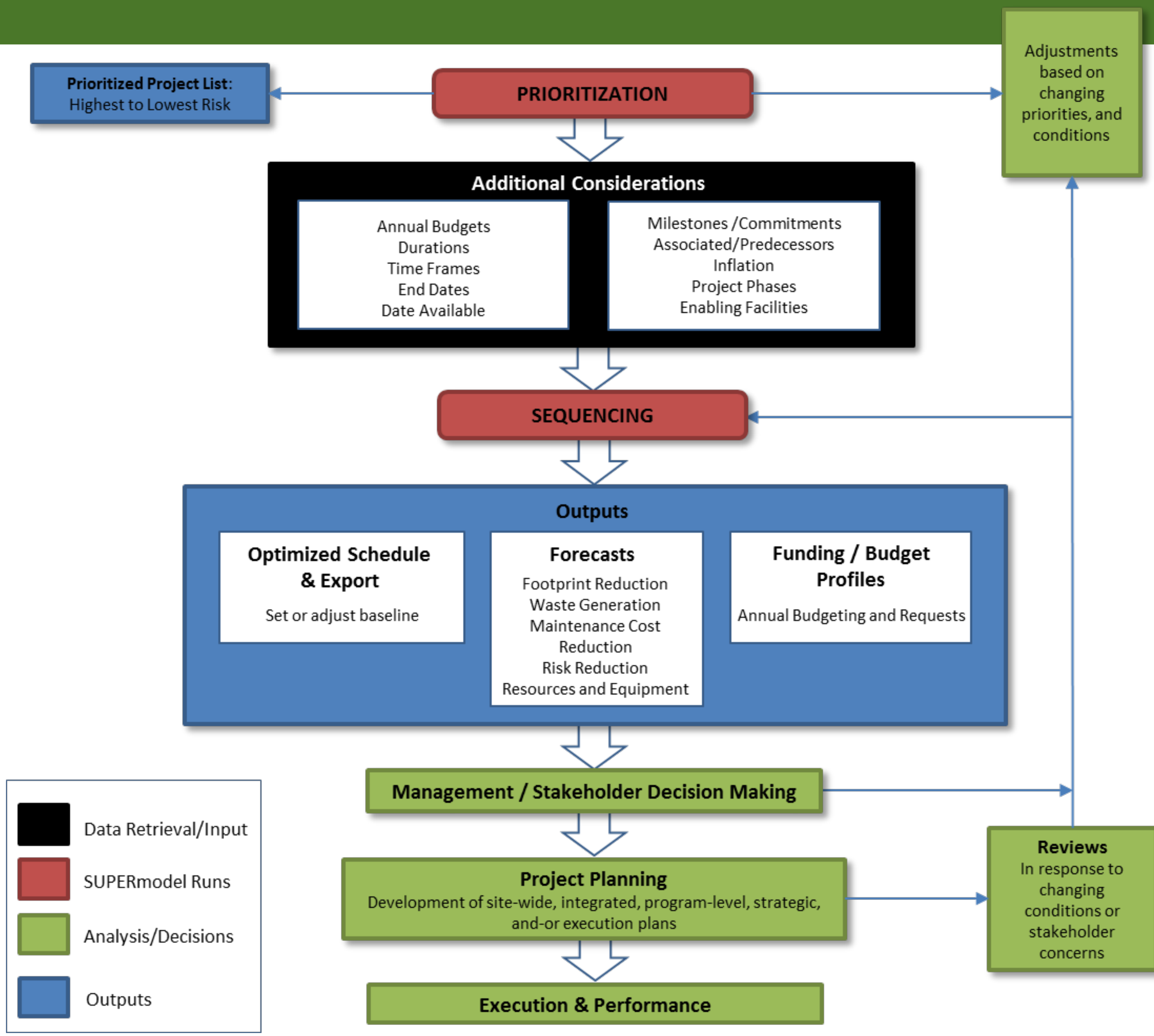
- Developed a technically objective and repeatable prioritization process and basis
- Engaged stakeholders throughout process to obtain input and buy-in of the risk evaluation criteria and process
- Performed prioritization (risk ranking) of NLLP projects
- Developed independent ROM cost estimates for facility decommissioning and a select number of environmental remediation projects
  - Can be compared to actual costs or used for benchmarking
- As a by-product, updated and consolidated project data is now in one central database

Proposed Next Steps



- Finalize the prioritization results
- Conduct sequencing and schedule optimization
  - Addresses cost, schedule, operations, budget, and other stakeholder constraints
  - Provides ability to conduct ‘unconstrained’ model runs
- Use as a consistent prioritization process to support more detailed annual planning

SUPERmodel Process: Next Steps - Sequencing



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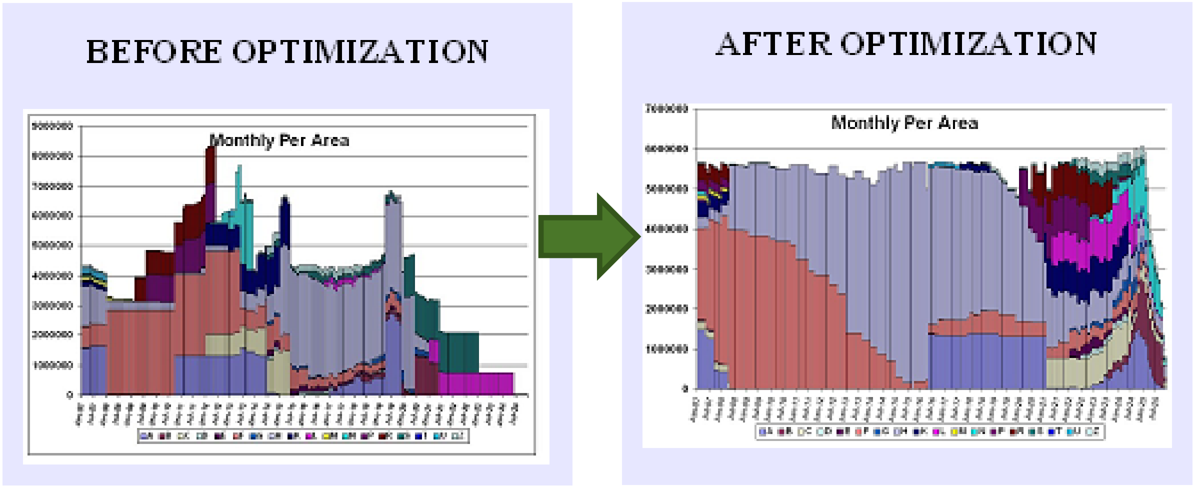
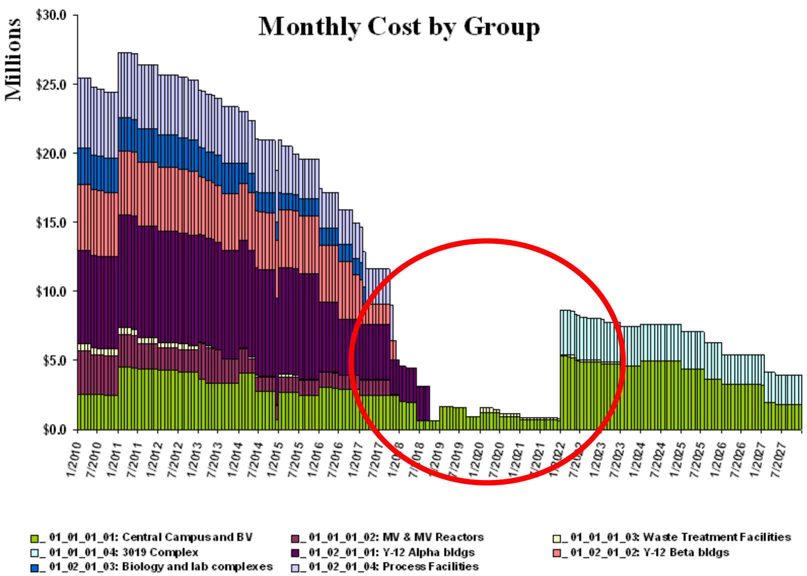
Sequencing:
Maximizing the Benefits of Prioritization

- Conducts ‘what if’ scenarios to evaluate impacts of changes in priorities, budgets, timeframes, risks, etc.
- Provide forecasts (e.g. Maintenance reductions, budget, waste generation, footprint reduction, resources, etc.)
- Utilizes prioritization to provide an optimal sequence (i.e. project schedule) based on constraints



Sequencing: Maximizing the Benefits of Prioritization

- Instant visibility of gaps in projects or funding
- Supports strategic and integrated planning and budgeting
- Forecasts budgeting, waste forecasting, resources, equipment
- Produces and optimized schedule for any portfolio to reduce maintenance/monitoring costs and maximize benefits
- Win-Win-Win for all stakeholders

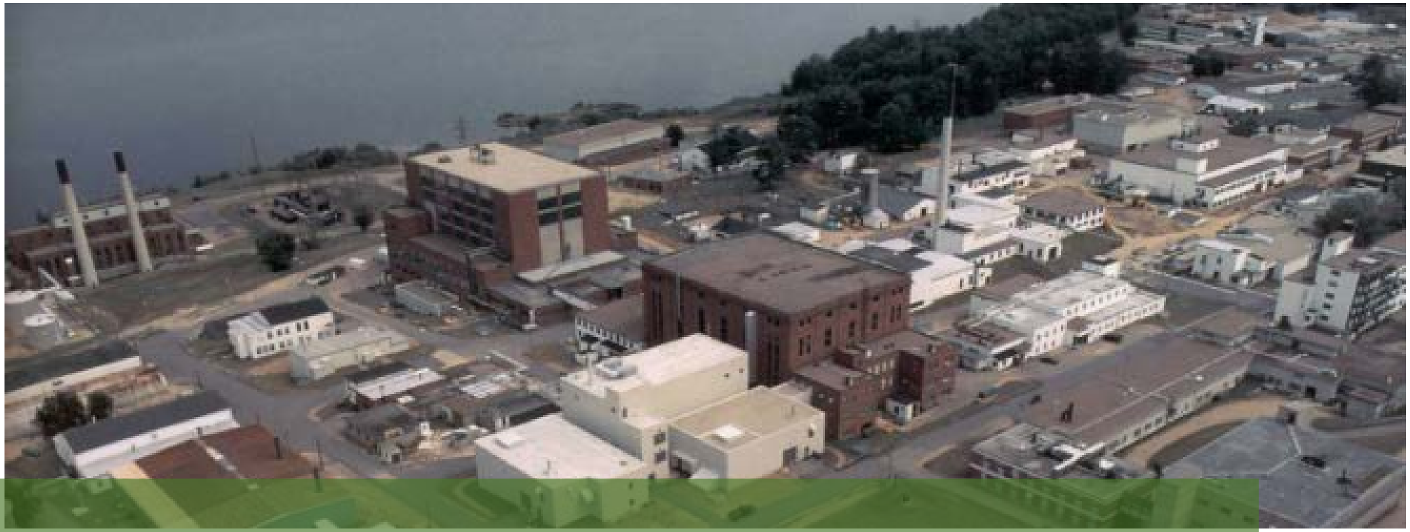


Proven SUPERmodel Results & Impacts

…the risk model (SUPERmodel) was designed… to make D&D decisions and already considers the impact of off-site receptors when assigning a risk score. If Environmental Management used the Model [SUPERmodel] and focused on risk for prioritizing its D&D activities, this issue would have already been addressed.

This would have led to reduction of the annual C&M costs by $2.2M instead of $306K and reduced the D&D costs incurred by $20M and conducted the additional D&D of over 20 facilities.

---US. Inspector General Audit



Thank you

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