CONF-960212--12

INTEGRATED WASTEWATER MANAGEMENT PLANNING FOR DOE'S ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

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ABSTRACT

Rocky Mountain Remediation Services, L.L.C. (RMRS), jointly formed by Morrison Knudsen Corporation and BNFL Inc., provides international experience in the nuclear, environmental, waste management, decontamination and decommissioning (D&D) , and project management industry. The company is currently the environmental restoration, waste management, and D&D subcontractor for Kaiser-Hill Company at the Rocky Flats Environmental Technology Site (RFETS). RMRS offers unique solutions and state-of-the-art technology to assist in resolving the issues that face industries today.

RMRS has been working on methods to improve cost savings recognized at RFETS, through application of unique technologies and process engineering. RMRS prepared and is implementing a strategy that focused on identifying an approach to improve cost savings in current wastewater treatment systems and to define a low-cost, safe and versatile wastewater treatment system for the future. Development of this strategy was targeted by Department of Energy (DOE) Headquarters, DOE Rocky Flats Field Office and Kaiser-Hill as a "Project Breakthrough" where old concepts were thrown out the door and the project goals and objectives were developed from the ground up. The objectives of the strategy developed in a project break through session with DOE included lower lifecycle costs, shutdown of one of two buildings at RFETS, Building 374 or Building 774, reduced government capital investment, and support of site closure program goals, identified as the site's Accelerated Site Action Plan (ASAP). The recommended option allows for removal of water treatment functions from Building 374, the existing process wastewater treatment facility. This option affords the lowest capital cost, lowest unit operating cost, lowest technical management risk, greatest support of ASAP phasing and provides the greatest flexibility for design with unforeseen future needs.

The recommended alternative provides for substantial near-term cost and technological advantages over the present operating baseline and planned capital improvement program. The total estimated capital expenditures for the recommended alternative is $6.8 million which is considerably less than the current capital funding level of approximately $65 million for full upgrades to Building 374. In addition, the recommended alternative saves approximately $6.1 million per year in operating costs. Accelerated program implementation will produce the desired improvements as specified by the key objectives, and will release capital and operating funds for investment in the site's higher risk reduction activities, supporting ASAP programs.

RMRS and Kaiser-Hill recommended, and DOE concurred, that as a result of the project's low Net Present Value and financial and technical rate of return, the preferred recommendation be implemented through a single consolidated project. A single consolidated project will allow for direct focus across multiple functional programs (i.e., Operations, Permitting, Environmental, etc.) assuring schedule and cost compliance. RMRS also recommended that the Project Implementation Plan be prepared to support Fixed Price and Fixed Unit Price contracting terms as a means of assuring the following:

- Accelerated schedule implementation;
- Competitive project cost;
- Government/commercial risk sharing; and
- Reduced government capital investment.

BACKGROUND

RFETS is a government-owned, contractor-operated facility which is a part of the nationwide DOE nuclear weapons production complex. Prior to 1989, the primary mission of the site was the continual production of components for nuclear weapons. Production activities included metalworking, fabrication and component assembly, plutonium recovery and purification, and associated quality control functions ensuring the technical performance of the weapons' components. The plant was built in 1951 and began operations in 1952. In 1989, as a result of a changing international political

climate, the decision was made by the United States government to discontinue production of components for nuclear weapons at Rocky Flats. Rocky Flats has undergone a transition from a weapons production facility to an environmental restoration and waste management site. The current mission of the site is to manage waste and material, clean up and convert RFETS to beneficial use in a manner that is safe, environmentally and socially responsible, physically secure and cost-effective.

The need for an integrated waste water management strategy was driven by the following:

- the need to reduce routine facility operating costs, to provide financing of risk reduction activities, and to provide support to site closure activities requiring accelerated waste water treatment to support deactivation and decommissioning activities over a 10-year period.

- major near-term facility improvements would be necessary to keep existing wastewater treatment facilities operational to support deactivation and decommissioning activities.

- negotiations on regulatory relief from overly restrictive stream standards and defining necessary and sufficient standards will impact the requirements for waste water treatment.

- changes in site mission from a weapons production mission to waste management, environmental clean-up and conversion to beneficial use have dramatically shifted the requirements for wastewater treatment.

PURPOSE AND OBJECTIVES

RFETS will continue to produce diverse wastewater streams as it completes its mission of environmental restoration, D&D, and waste management. This study included the integration of previous wastewater management strategies into one overall strategy and the provision for cost-effective treatment of all wastewater to be produced at the site. Alternatives developed in the study were designed to support the ASAP site closure concept.

The primary objective of this document was to develop and document the basis of this strategy and to develop short- and long-term implementation plans. To achieve the primary objective, the following supporting objectives were identified.

- The strategy must integrate multiple focused wastewater management strategies already in place or in preparation into one overall strategy.
- The strategy must evaluate the routing and treatment of wastewater streams based on composition and regulatory requirements rather than the point of generation.
- The strategy must ensure that adequate capacity is provided for all wastewater treatment over the foreseeable future.
- The strategy will be integrated into the RFETS Water Management Plan.
- The strategy must contain information on the identity and characteristics of all known wastewater sources and conveyance methods on the site. This will allow for identification of waste segregation and minimization opportunities. In addition, impacts of wastewater stream elimination on the balance of the wastewater to be treated can be evaluated.
- The strategy must identify which wastewater treatment facilities currently in operation can be cost-effective components in an overall strategy.

Development of the strategy considered all current and anticipated sources of wastewater potentially requiring treatment. This included wastewater from domestic use, building process operations, facility deactivation, facility decontamination and decommissioning, and environmental restoration. Excluding domestic wastewater, the largest sources of wastewater in terms of average annual volume projected for the future include the Interceptor Trench System (ITS) (3.5 million gallons per year), the Building 566 laundry (1.3 million gallons per year), and environmental restoration activities, primarily

groundwater (up to 6.5 million gallons per year). The actual volume of environmental restoration water could decrease dramatically depending upon final agreements on cleanup levels. Facility deactivation will also produce the most highly contaminated wastewater, although volumes will be low in comparison to the total of the other major sources (greater than 1 million gallons per year). Deactivation wastewater production will also peak fairly rapidly and then begin to decline, and will only be produced over the next one to five years. Characteristics and estimated volumes of future process wastewater sources are shown in Exhibit 1.

"Place Exhibit 1 here"

Development of the strategy also considered the capacities and capabilities of existing treatment facilities at Building 374, Building 774, Building 995 (the Sanitary Treatment Plant (STP)), and the Site Treatment Facility (treatment of water generated from environmental restoration activities).

ALTERNATIVES EVALUATED

Four alternatives were identified for wastewater treatment. These alternatives support achievement of the ASAP site closure goal, and include the following:

- Alternative 1 - Minimum Building 374 upgrades;
- Alternative 2 - Building 374 Liquid Waste Treatment Facility upgrades;
- Alternative 3 - Building 374 Waste system Evaporator upgrades; and
- Alternative 4 - Building 374 Elimination

These alternatives were subjected to a technical and cost effectiveness evaluation and a sensitivity analysis, and a final selection made. Alternative 4 (see schematics in Exhibits 2 and 3) was selected as the recommended alternative for the following reasons:

- It is the only alternative capable of supporting an early closure of Building 374 and can also support closure of building 771/774,
- It has the lowest overall life cycle cost of dollars and capital cost dollars of the ten-year alternatives,
- It has low risk of delay in implementation because of relatively low capital funding requirements;
- It is ranked high technically due primarily to minimization of waste and overall flexibility in addressing changes in wastewater characteristics, and
- It is the best alternative to support achievement of the ASAP closure goals.

"Place Exhibits 2 & 3 here"

The estimated costs of the recommended alternative is summarized below:

DOE Capital Investment	$6,800,000
Average O&M Costs	$8,100,000

These costs demonstrate the following savings over current operations:

- The total estimated capital expenditures for the recommended alternatives is $6.8 million, which is considerably lower than the current capital funding level of approximately $65 million for full upgrades to Building 374.
- The current operating budget of Building 374 is approximately $9.3 million. If operations of the Sitewide Treatment Facility and waste disposal are added, this cost increases to approximately $14.2 million. The recommended alternative saves approximately $6.1 million.

- An overall life cycle cost curve for the recommended alternative is illustrated in Exhibit 4.

"Place Exhibit 4 here"

IMPLEMENTATION

Implementation of the strategy was approved by DOE in November, 1995 and alternative treatment technologies have been evaluated and a Conceptual Design Report subsequently prepared. The conceptual design includes the following features.

- Building 374 will be closed in FY 97 and a new temporary treatment facility (TTF) will be designed and constructed to treat wastewater from building operations, deactivation, and decontamination and decommissioning. This facility will be located near Building 374 to take advantage of existing collection and support systems. Either leased or modular equipment will be utilized in the facility as the operational life of the facility will be less than ten years.

- Regulatory relief has been sought on the existing plutonium standard for discharges from the TTF facility. This relief is based on raising the plutonium level from the current site specific standard to the Statewide plutonium standard for up to five years while tanks are drained and pipelines are flushed during initial D&D activities. Review of historic records shows that the proposed increase in stream loading would only double the loading over levels discharged in the last five years but would not be a risk to human health or the environment. This temporary modification, currently being negotiated with the regulatory agencies would save approximately $73 million in capital and operating costs which could be redirected to higher priority risk reduction activities.

- Liquids produced from deactivation activities in Building 371 will be treated for initial reduction of radionuclide and metal concentrations in the caustic waste treatment system to be installed in Building 371. Treated effluent from this process could then be treated in the Building 774 carrier precipitation process for additional radionuclide removal. The supernatant wastewater from both Buildings 371 and 774 will then be treated for further reduction of radionuclides and metals in the new temporary facility replacing Building 374.

- The general approach to handling of deactivation wastewater is shown schematically on Exhibit 3. Liquids produced from deactivation activities in Building 771 will be treated for initial reduction of radionuclide and metal concentrations in the oxalate precipitation process and hydroxide precipitation process located in Building 771. Additional treatment of the effluent from these processes plus other miscellaneous liquids produced in Building 771 and 774 will be treated in the carrier precipitation process in Building 774.

- A temporary sludge immobilization system (TSIS) is being designed to treat sludges currently stored in Building 374 and Building 774, and for sludges produced by the Building 774 carrier precipitation process. TSIS is a mobile system that can be reassembled elsewhere on-site or offsite to treat other sludges or waste forms.

- Regulatory relief on nitrate and uranium limits has been sought to allow for direct discharge of ITS wastewater. This relief is based on removing the water supply use classification from Walnut Creek but leaving the agricultural use classification, thereby allowing for compliance with nitrate standards (based on no risk to human health or the environment for nitrates) and use of statistical methods to prove that uranium levels were below background concentrations. These actions are estimated to save $20 million dollars over a ten year period. Recent meetings with regulatory agencies and Stakeholders on regulatory

relief have been positive and it appears that all parties will now request the Colorado Water Quality Control Commission to revise the stream standards.

- Characterization of Building 566 laundry wastewater has been conducted to verify that discharge to the STP can take place and this stream has subsequently been eliminated from Building 374.

- RMRS has worked with DOE and Kaiser-Hill to obtain variances from DOE Orders and Plant Standards in the application of necessary and sufficient standards in engineering, installation and operation, thereby producing substantial capital and operating cost reduction while allowing for commercial equivalent practices.

CONTRACTING/FINANCING APPROACH

The Kaiser-Hill team has committed to performance-based contracting with an evolution toward commercialized fixed-price contracting. In addition, the ASAP necessitates a projectized approach to providing improved near-term treatment services in conjunction with lower building and routine operating costs, supporting funding of high priority risk reduction activities. As a result, RMRS looked at several options to expedite the contracting approach, including using commercialized contracting and both cost plus fixed fee and fixed unit price contracting strategies.

A typical cost plus fixed fee approach would require the government to pay for design and installation of the facility and capitalization of the equipment without an assurance that the plant would perform. In addition, the government would own the building, and with the approach proposed by ASAP, this is in contradiction to taking the site down.

The approach that RMRS proposes is a fixed price services contract, whereby RMRS provides equipment and the services associated with that equipment.

FUTURE PLANNING AND INTEGRATION

The schedule for implementation of this strategy for the recommended alternative is presented in Exhibit 5.

"Place Exhibit 5 here"

CONCLUSIONS

Kaiser-Hill and RMRS have committed to accelerated closure of RFETS buildings as a means of substantial cost savings to the government. Implementation of the Integrated Wastewater Management Strategy is in keeping with this philosophy as it allows for early closure of Building 374, thereby allowing funds to be reallocated for other site closure activities. Assuming that accelerated funding is available and a design-build approach to procurement approved, Building 374 can be closed in FY 1997. The driver for this date is the completion of the design and construction of the new facilities. Given the services contract approach, an acceleration of 12 to 24 months is anticipated./

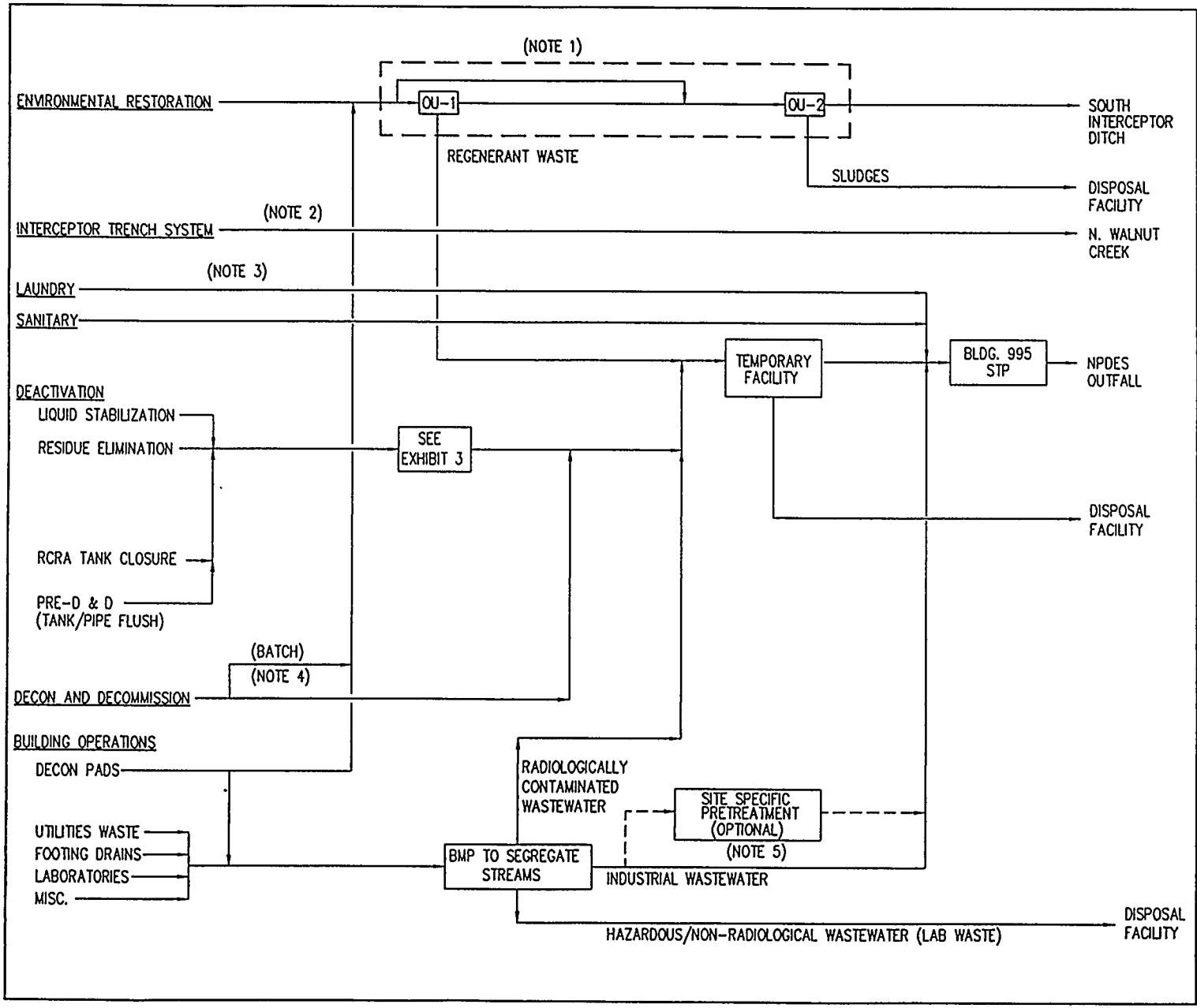
Lessons learned from this DOE breakthrough project are applicable to other DOE and DOD facilities. Revisiting existing baseline operations may show that substantial near-term cost savings can be realized and these funds can then be redirected for other activities. Alternate contracting strategies may also reduce required government capital investment and lead to sharing of risk between the government and contractors. There is also a need to reassess existing cleanup levels to see if there is a good risk basis for negotiating changes to standards to reduce operating costs.

Exhibit 1
PROJECTED WASTEWATER CHARACTERISTICS

WASTEWATER SOURCE	PROJECTED FLOW (GPY) a/	PROJECTED TREATMENT CAPACITY (GPM) b/	DURATION	PROJECTED CONTAMINANTS OF CONCERN
Landfills				
New Sanitary Landfill	20,000	0.15 - 0.21	2036	Organics, Metals
CAMU	1,500,000	11 - 16	1999	Organics, Metals, Radionuclides
Environmental Restoration				
Groundwater	6,570,000	51 - 72	2015	Organics, Metals, Radionuclides
Interceptor Trench System	1,400,000	11- 15	2015	Nitrate/Nitrite, Radionuclides
Laundry	1,300,000	9.9 - 14	2015	Metals, Biological Oxygen Demand
Sanitary	55,000,000	420 - 590	2015	Biological Oxygen Demand, Inorganics
Building Deactivation				
Liquid Stabilization	8,800	0.07 - 0.09	1999	Actinides, Metals
Residue Elimination	26,400	0.2 - 0.3	2002	Actinides, Metals
Tank Management	885,000	6.7 - 9.4	2005	Actinides, Metals
Bld 374/774 Sludge Treatment	34,000	0.2 - 0.4	2015	Actinides, Metals
Decontamination and Decommissioning	100,000	0.8 - 1.1	2015	Metals, Radionuclides
Building Operations	870,000	5.3 - 7.4	2015	Metals, Radionuclides, Inorganics
Incidental	3,100,000	24 - 33	2015	Metals, Radionuclides, Organics

a) GPY = gallons per year

b) GPM = gallons per minute. The range for treatment capacity required in GPM was calculated assuming an 8 hour per day treatment operation at 75% online efficiency for a range from 260 days per year to 365 days per year.



NOTES:

1. THE OU-1 AND OU-2 FACILITIES HAVE BEEN COMBINED INTO A SINGLE COMPLEX.
2. REGULATORY RELIEF TO ALLOW DIRECT DISCHARGE OF INTERCEPTOR TRENCH WASTEWATER TO N. WALNUT CREEK. INTERIM DISCHARGE UNTIL RELIEF OBTAINED WOULD BE TO BUILDING 374 WSE. FAILURE TO OBTAIN RELIEF WOULD REQUIRE DESIGN AND CONSTRUCTION OF A DEDICATED TREATMENT FACILITY FOR THIS STREAM.
3. ONLY MODESTY CLOTHING CLEANED ONSITE. ALL OTHER LAUNDRY SHIPPED OFF-SITE. LOCAL PRETREATMENT MAY BE REQUIRED.
4. SOME BATCHES OF DECONTAMINATION AND DECOMMISSIONING WASTE MAY CONTAIN ORGANICS OR OTHER CONSTITUENTS MORE APPROPRIATE FOR TREATMENT AT OU-1 OR OU-2. THESE BATCHES WILL BE TRANSPORTED VIA TANKER TRUCK OR PORTABLE TANK.
5. INDIVIDUAL BUILDINGS MAY NEED TO PRETREAT TO MEET STP WASTE ACCEPTANCE CRITERIA.

DEFINITIONS:

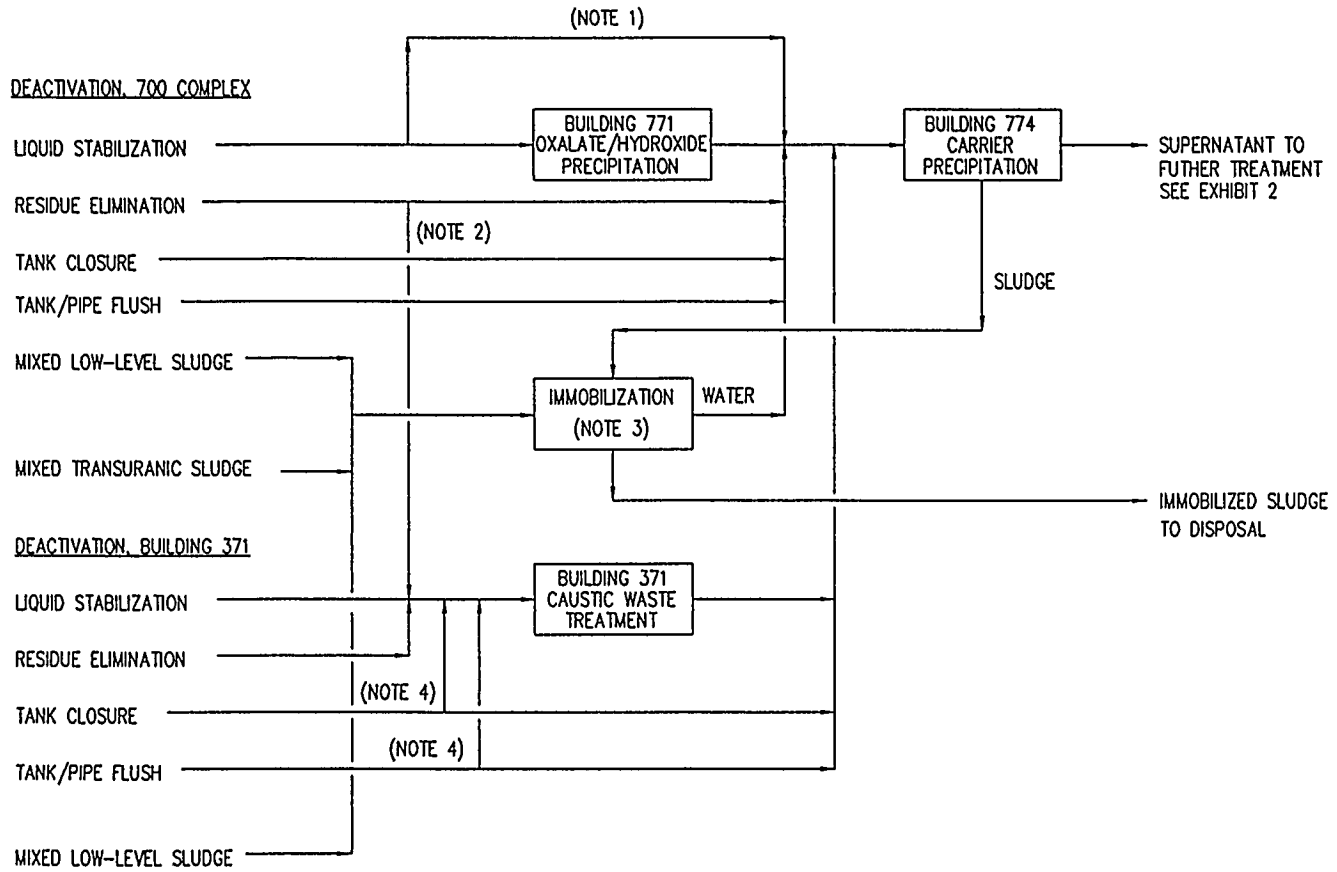
OU-1 = EXISTING OPERABLE UNIT-1 TREATMENT SYSTEM
OU-2 = EXISTING OPERABLE UNIT-2 TREATMENT SYSTEM
LWTF = BUILDING 374 LIQUID WASTE TREATMENT FACILITY, KNOWN AS THE "HOT SIDE"; AND TREATS RADIOACTIVELY CONTAMINATED WASTEWATER.
WSE = BUILDING 374 WASTE SYSTEM EVAPORATOR. KNOWN AS THE "COLD SIDE"; AND TREATS DECONTAMINATED AND OTHER SLIGHTLY CONTAMINATED WASTEWATER.
BMP = BEST MANAGEMENT PRACTICES. REFERS TO ADMINISTRATIVE AND ENGINEERING CONTROLS TO MINIMIZE CONTAMINATED WASTEWATER PRODUCTION.
STP = SANITARY TREATMENT PLANT

EXHIBIT 2

RFETS SWTS STUDY CONCEPTUAL FLOW DIAGRAM

ALTERNATIVE 4

BUILDING 374 ELIMINATION



NOTE:
DEACTIVATION IN THE 700 COMPLEX AND BUILDING 371
IS ASSUMED TO BE COMPLETE IN FOUR YEARS.

NOTES:

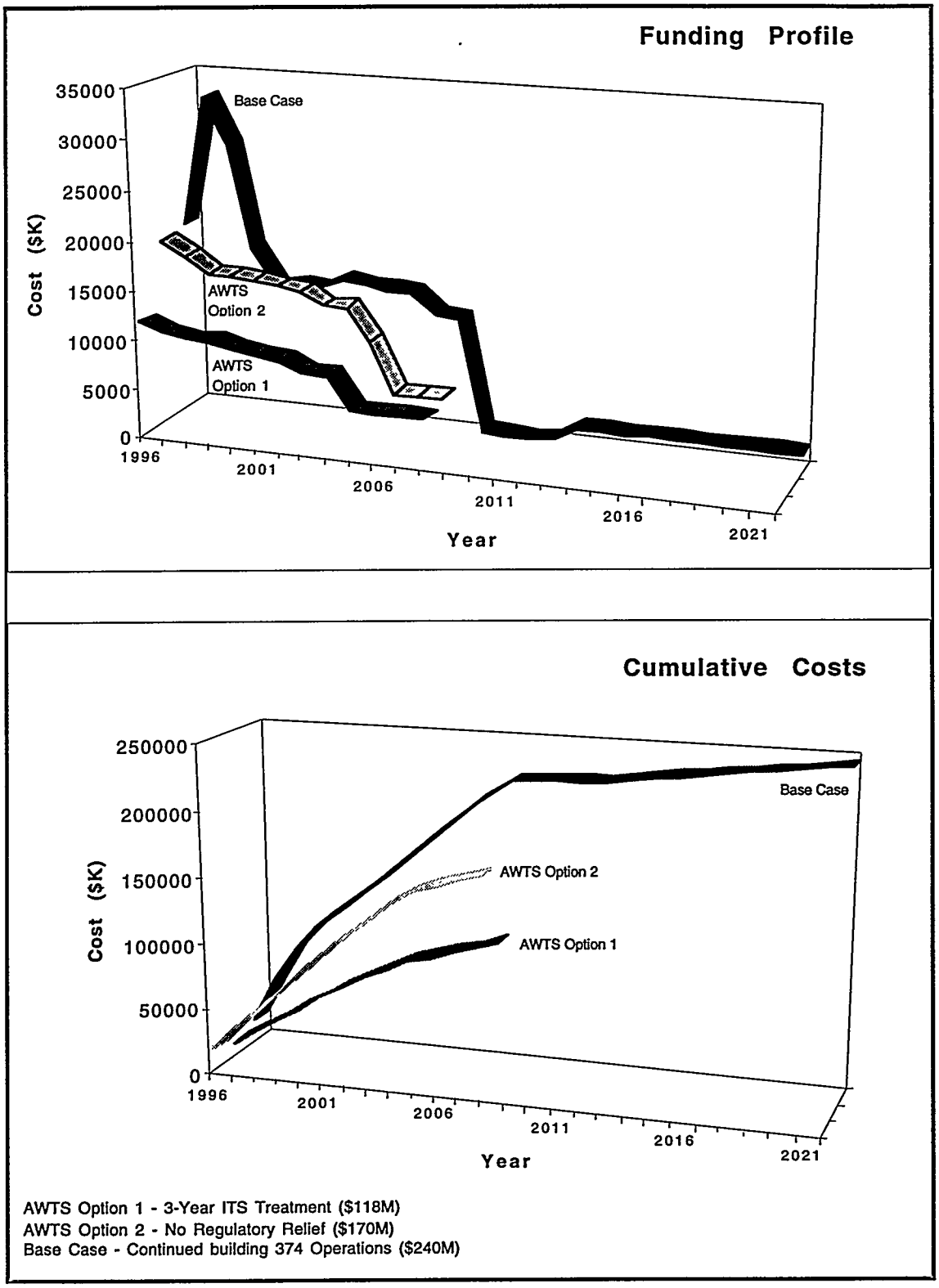
1. DEPENDING ON ACTIVITY LEVELS, SOME LIQUID STABILIZATION WASTEWATER WILL NOT REQUIRE OXALATE /HYDROXIDE PRECIPITATION.
2. SOME RESIDUE ELIMINATION WASTEWATER MAY BE TRANSPORTED TO BUILDING 371 FOR TREATMENT.
3. FINAL IMMOBILIZATION SYSTEM PLANNING FOR THESE SLUDGES ARE IN DEVELOPMENT.
4. DEPENDING ON ACTIVITY LEVELS, SOME TANK CLOSURE AND TANK/PIPE FLUSH WASTEWATER MAY BE PRETREATED IN THE BUILDING 371 CAUSTIC WASTE TREATMENT SYSTEM.

EXHIBIT 3

RFETS SWTS STUDY
CONCEPTUAL
FLOW DIAGRAM

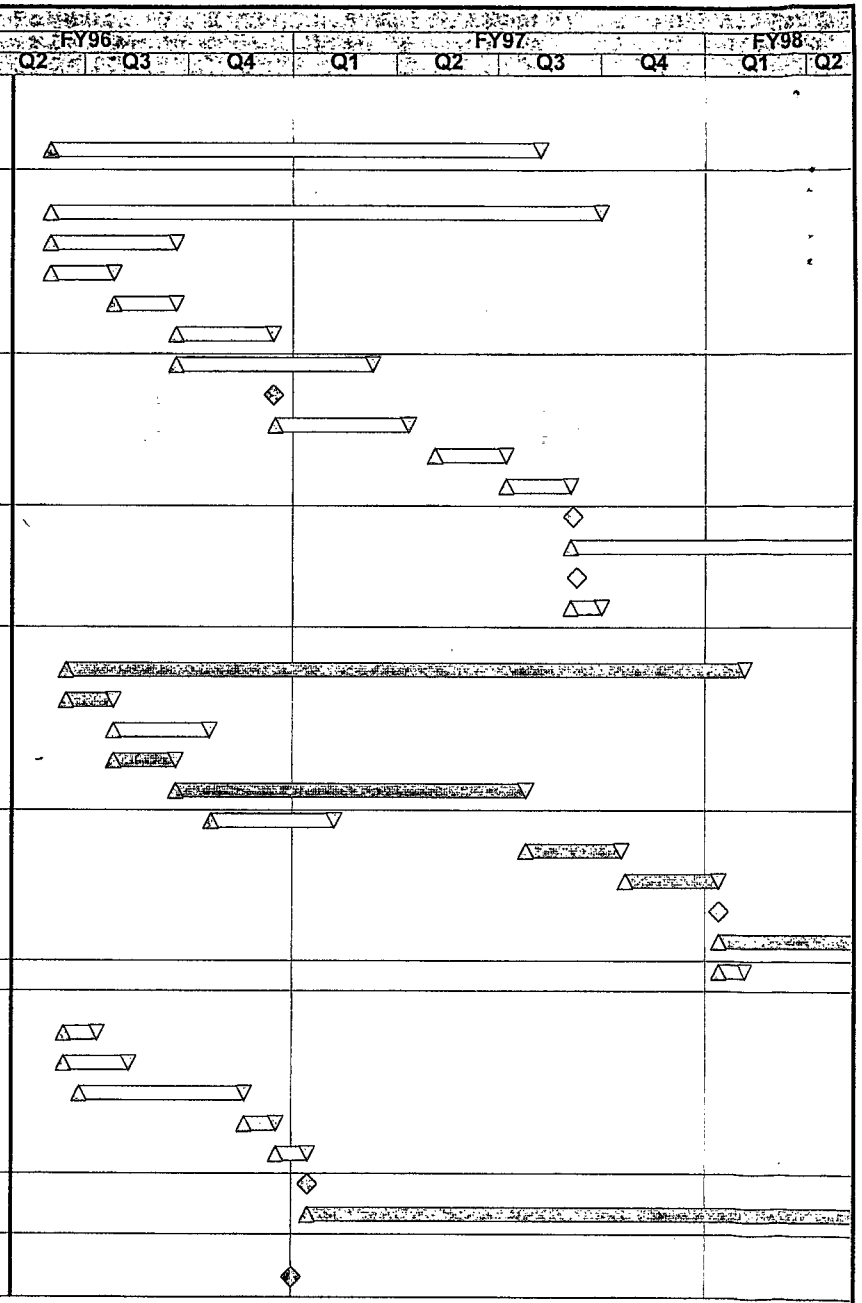
FACILITY DEACTIVATION SCHEMATIC

EXHIBIT 4
ALTERNATIVE WATER TREATMENT SYSTEM LIFE CYCLE COSTS



AWTS Option 1 - 3-Year ITS Treatment ($118M)
AWTS Option 2 - No Regulatory Relief ($170M)
Base Case - Continued building 374 Operations ($240M)

Activity description	RESP	Early start	Early Finish
PERMITTING & COMPLIANCE			
Permitting and Compliance	SUBCONTR	01MAR96	07MAY97
TEMPORARY TREATMENT FACILITY (TTF)			
Temp Treatment Facil. (TTF)	SUBCONTR	01MAR96	30JUN97
Bldg design	SUBCONTR	01MAR96	20JUN96
TTF system spec	SUBCONTR	01MAR96	25APR96
TTF system procurement	SUBCONTR	26APR96	20JUN96
Bldg procurement	SUBCONTR	21JUN96	13SEP96
TTF system fab & delivery	SUBCONTR	21JUN96	09DEC96
Bldg erection start	SUBCONTR		13SEP96
Bldg erection	SUBCONTR	16SEP96	10JAN97
TTF system installation	SUBCONTR	04FEB97	07APR97
TTF startup	SUBCONTR	08APR97	02JUN97
TTF Operational	SUBCONTR		03JUN97
TTF Operations	SUBCONTR	03JUN97	31MAY02
Bldg. 374 WSE Shutdown	SUBCONTR		06JUN97
TTF team demobilization	SUBCONTR	03JUN97	30JUN97
TEMPORARY SLUDGE IMMOBILIZATION SYSTEM (TSIS)			
Temp Sludge Immobilization System (TSIS)	SUBCONTR	15MAR96	07NOV97
TSIS system spec	SUBCONTR	15MAR96	25APR96
TSIS site prep/support design	SUBCONTR	26APR96	19JUL96
TSIS procurement	SUBCONTR	26APR96	20JUN96
TSIS Fab & delivery	SUBCONTR	21JUN96	24APR97
Site work/support utilities constr	SUBCONTR	22JUL96	06NOV96
TSIS installation	SUBCONTR	25APR97	18JUL97
TSIS startup	SUBCONTR	21JUL97	13OCT97
TSIS operational	SUBCONTR		13OCT97*
TSIS Operations	SUBCONTR	14OCT97	14OCT02*
TSIS demobilization	SUBCONTR	14OCT97	07NOV97
INTERCEPTOR TRENCH SYSTEM			
ITS treatability study	SUBCONTR	14MAR96	11APR96
ITS vendor design	SUBCONTR	14MAR96	09MAY96
ITS fabrication & delivery	SUBCONTR	28MAR96	19AUG96
ITS installation	SUBCONTR	20AUG96	17SEP96
ITS startup	SUBCONTR	18SEP96	14OCT96
ITS operational	SUBCONTR		14OCT96
ITS Operations	SUBCONTR	15OCT96	15OCT99
LAUNDRY WATER DIVERSION			
Laundry Water Diversion	CONTRACTOR		30SEP96*



Project Start	01SEP95
Project Finish	14OCT02
Data Date	29JAN96
Plot Date	31JAN96

Early Bar
Progress Bar
Critical Activity

SCH1

Sheet 1 of 1

ROCKY MOUNTAIN REMEDIATION SERVICES
ALTERNATE WATER TREATMENT SYSTEM
EXHIBIT 5