CONCRETE DISPOSAL OPTIONS

PREPARED FOR

KAISER-HILL COMPANY

D & D PROJECTS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

BY

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CONCRETE DISPOSITION OPTIONS AT ROCKY FLATS

RFCA Principals Meeting

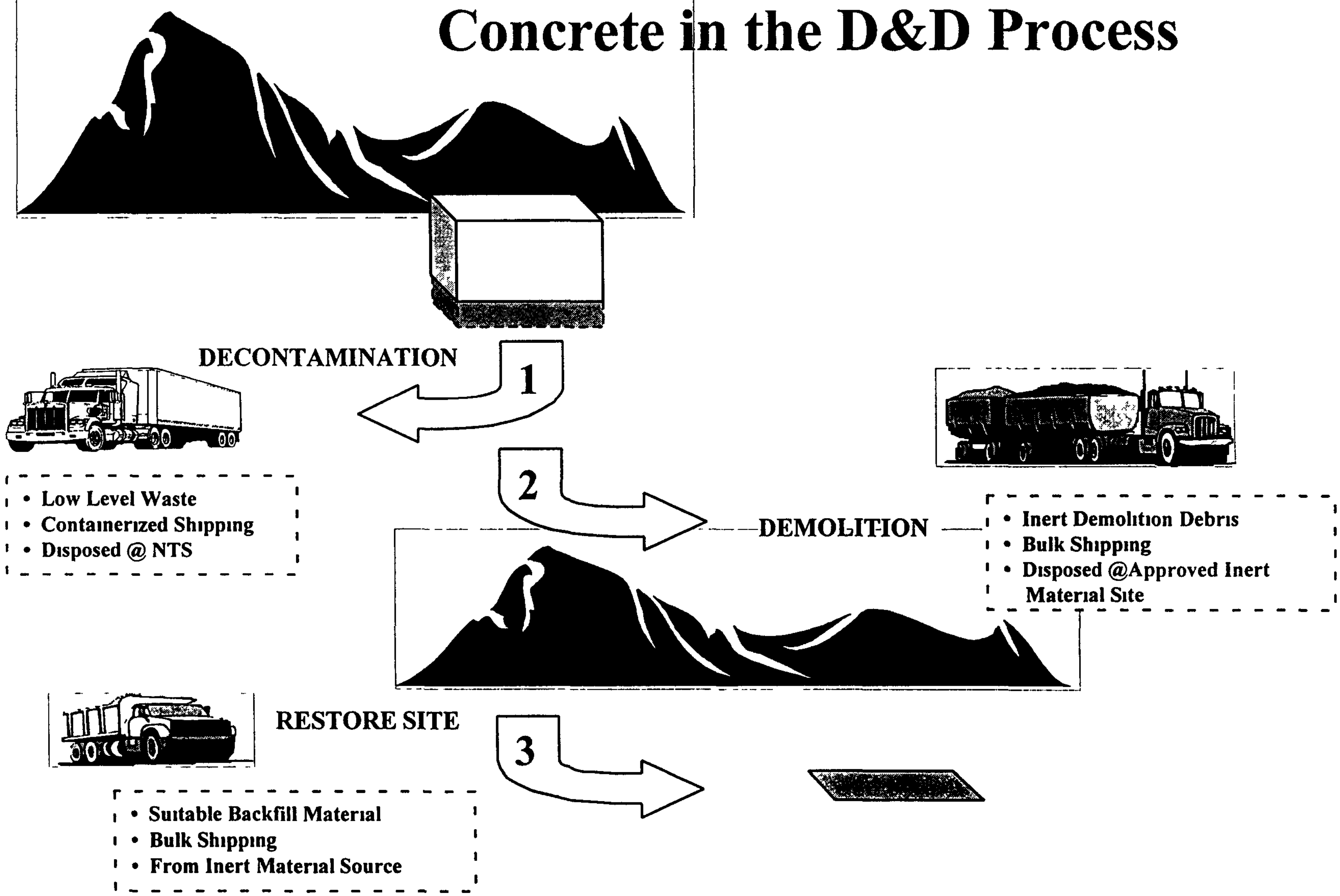
August 14, 1998

Issue

- Massive Volume of Concrete
- Wide Range of Disposition Options
- Need Decision on Options and Approach

Concrete Disposition Options

Concrete in the D&D Process



Basis / Assumptions

- **229,000 Metric Tons OR 100,000 Cubic Meters**
  (Gross Weight) (Solid Volume)

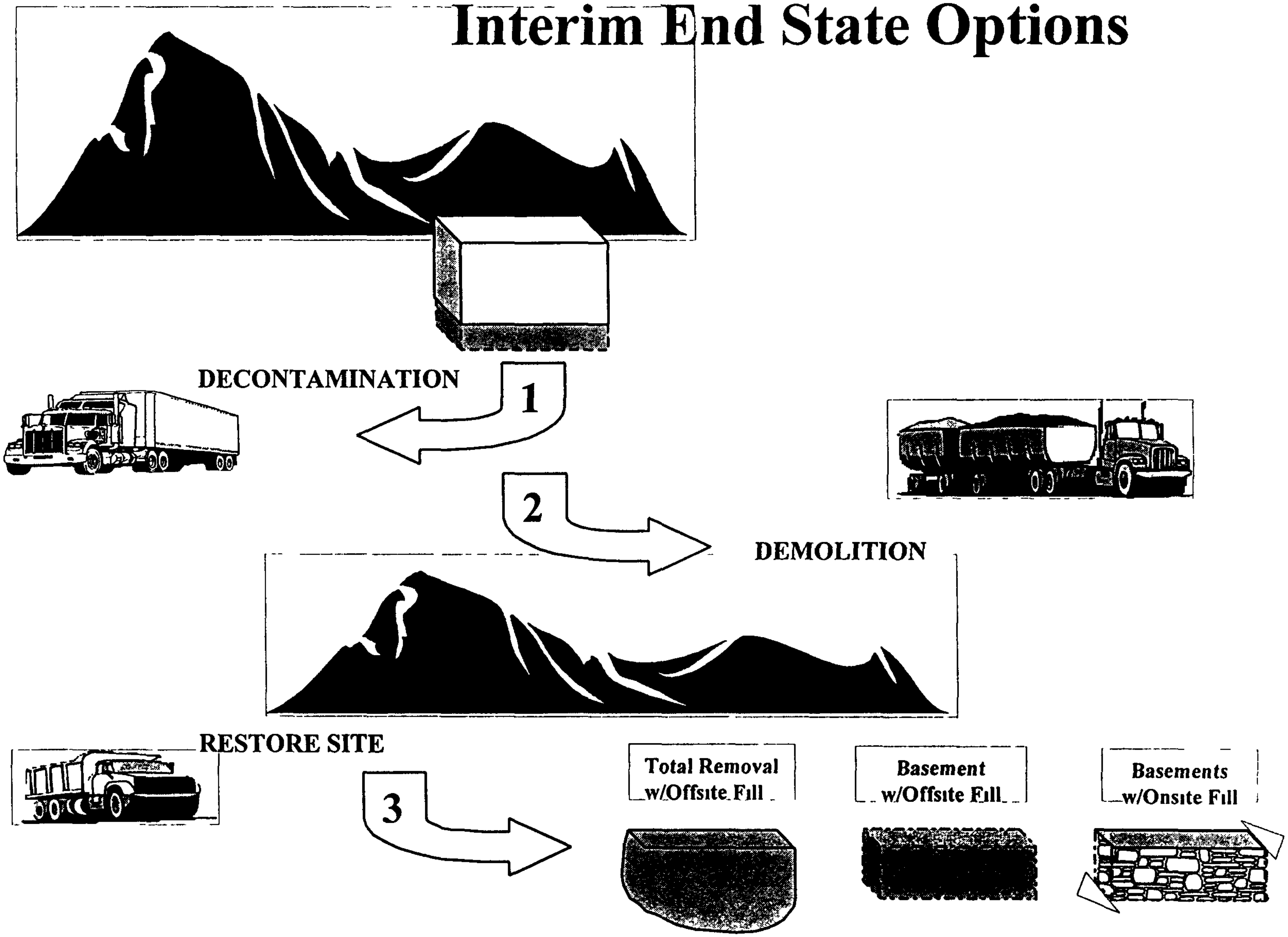
- **70% Above Grade --- 30% Below Grade**

- **Total of 33,000 Metric Tons Low Level Waste**
  - 11,550 Metric Tons LLW Removed as Solid Mass
  - 21,450 Metric Tons LLW Removed by Surface Decon

- **Demolition Cost Below Grade = 2x Above Grade**

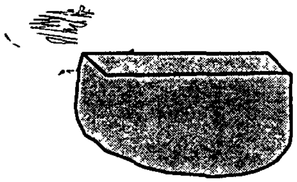
Concrete Disposition Options

Interim End State Options



Technical Approaches

Total Removal

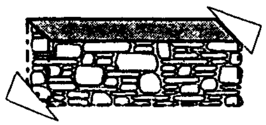


- All Low Level Waste
- 1” Decontamination
- Smart Characterization & Decontamination

Basements w/Off Site Fill

- 1” Decontamination
- Smart Characterization & Decontamination

Basements w/ On Site Fill



- 1” Decontamination
- Smart Characterization & Decontamination
- Crush and Separate Concrete Rubble

Evaluation Criteria

- **Safety** (Environmental and Worker Safety)
- **Budget Impact**
- **Stakeholder Acceptance** (Interim End State Compliance)
- **Schedule Performance**
- **Technical Feasibility**

Concrete Disposition Options

Relative Comparison

	TOTAL REMOVAL ALL MATERIAL DISPOSED OFF-SITE – DEMOLITION VOIDS FILLED WITH OFF-SITE FILL MATERIAL			BASEMENTS W/ OFF SITE FILL ABOVE GRADE RUBBLE REMOVED - BASEMENTS REMAIN & FILLED WITH OFF-SITE FILL MATERIAL		BASEMENTS W/ ON SITE FILL ABOVE GRADE RUBBLE DISPOSED IN BASEMENTS AND REMAINING VOIDS		
FACTOR	**All Low Level**	**1" Decon - Off Site Disposal**	**Smart C&D - Off Site Disposal**	**1" Decon - Basements Remain**	**Smart C&D - Basements Remain**	**1" Decon - Rubble in Basements**	**Smart C&D - Rubble in Basements**	**Concrete Crushing & Separations**
Worker Safety	H	L	M	L	M	L	M	H
Transportation (Total Trips) (Total Miles) [~Passes/Day]	xL (23,174) (19,400,000) [33]	L (23,114) (4,000,000) [33]	M (23,110) (2,900,000) [33]	M (17,567) (3,600,000) [25]	M (17,220) (2,500,000) [25]	H (4,684) (2,600,000) [7]	H (3,495) (1,500,000) [5]	H (4,997) (2,900,000) [7]
Budget Acceptance	L $185 2M	L $201 3M	H $117 7M	M $173 7M	H $92M	M $157 2M	H $81 6M	M $151 6M
Stakeholder Acceptance	H	H	H	M	M	L	L	M
Schedule Performance	H	L	M	L	H	M	H	H
Technical Feasibility	M	H	M	H	M	H	M	L

High (H) = Most desirable in range

Low (L) = Least desirable in range

Next Steps

- Continue Discussions and Analysis
- Identify Preferred Option and Approach
- Decision required by _______

CONCRETE DISPOSITION OPTIONS AT ROCKY FLATS

RFCA Principals Meeting
August 14, 1998

Introduce yourself and move into the Issue slide

Concrete Disposition Options

Issue

- **Massive Volume of Concrete**
- **Wide Range of Disposition Options**
- **Need Decision on Options and Approach**

o Closure of Rocky under RFCA will generate significant amounts of concrete

o Many options and technical approaches available to generate and dispose of concrete

o Selecting an option is key to the overall D&D Baseline which drives schedules and budgets

o Decision helps shape the physical character of the Industrial Use Interim End State

o A timely decision is critical to meeting RFCA closure requirements

o Our purpose is

- provide an overview of the options available and their impacts (common understanding)
- initiating a meaningful dialog focused on making this critical decision

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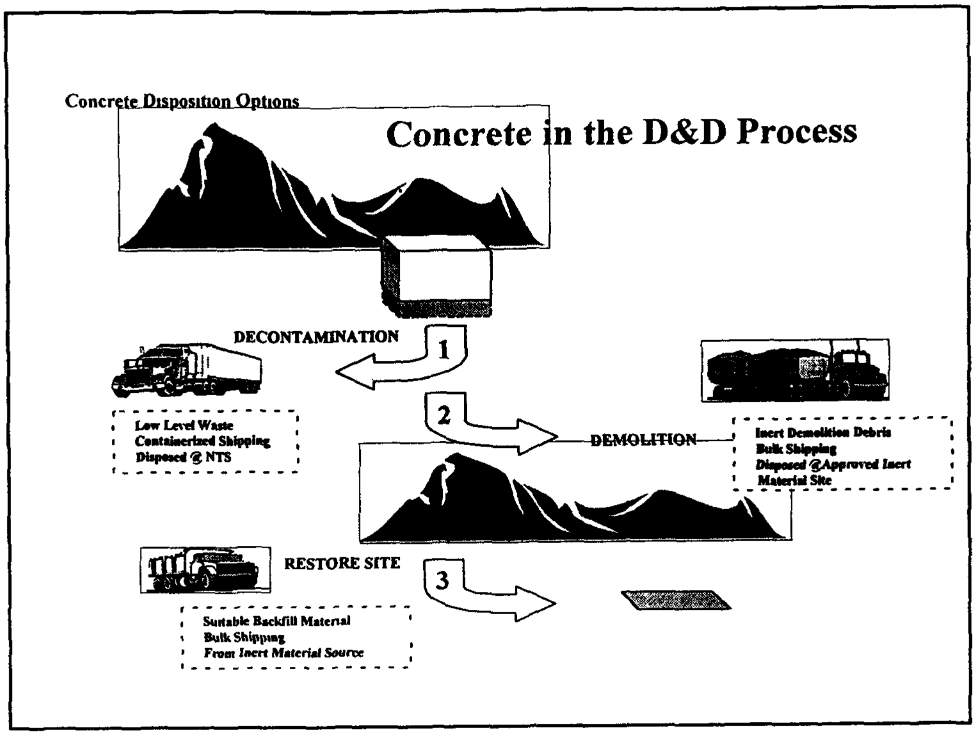
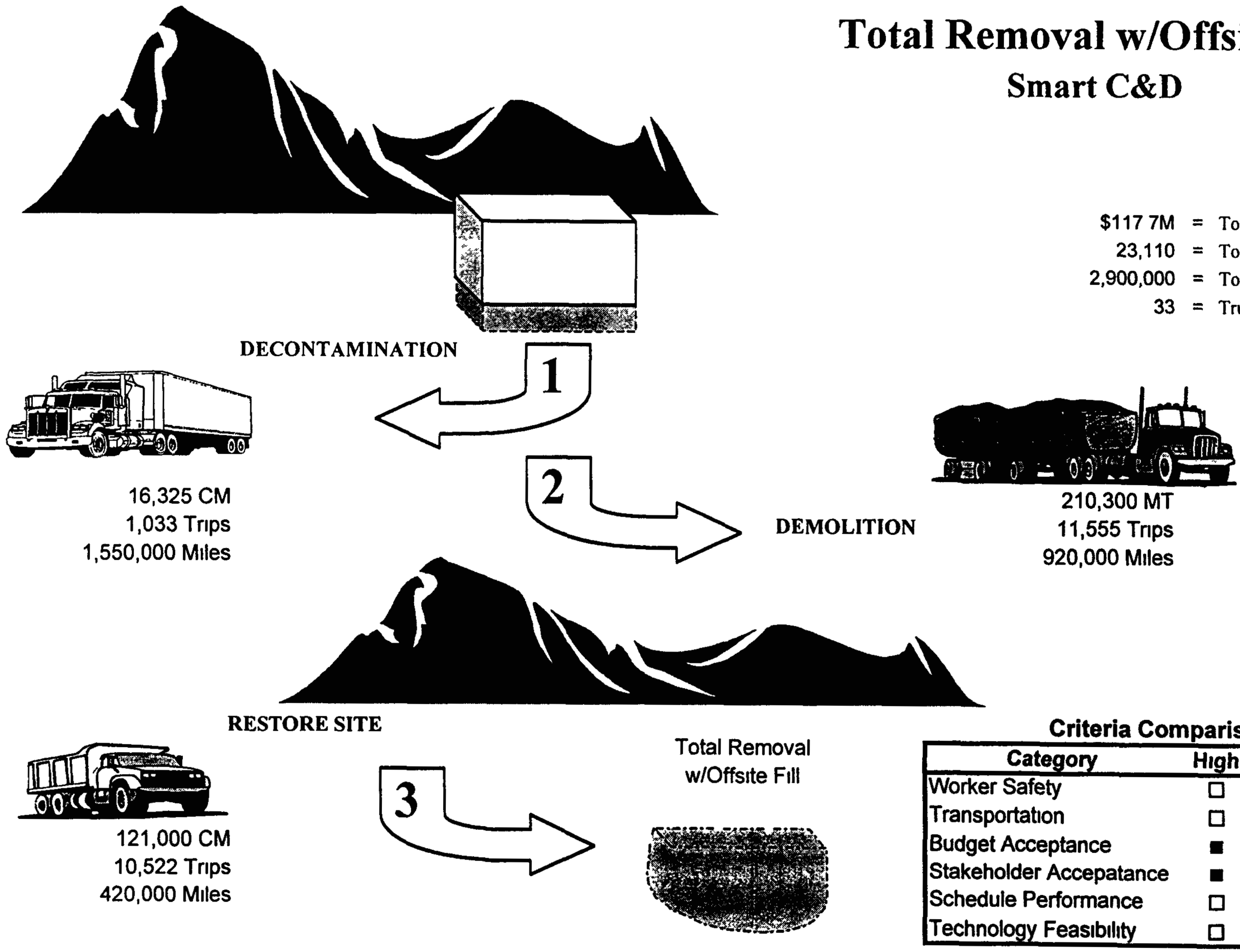


- o Current Estimates = 100,000 cm3 = structural concrete in 100+ buildings
  - many forms
    - PU bldgs = massive slabs
    - Process Bldgs = some massive slabs, thin slabs, and cinder block
    - Support Bldgs = thin slabs and cinder block
  - total volume = solid block the length and width of football field over 80 feet high
  - 70% above grade - 30% below grade (basements, tunnels, vaults, pits, foundations)
- o Generic process outlining three primary steps involved in dispositioning Rocky's concrete
  - Step One = Decontaminate
    - Remove Low Level Waste
    - Package in Containers (i e ,Boxes)
    - Ship to Approved LL Site (i e , NTS)
  - Step Two = Demolish
    - Create inert demolition debris
    - Bulk Shipping (i e , 40 YD Trucks)
    - Ship to Approved Inert Material Disposal Site (i e , Erie)
  - Step Three = Restore Site
    - Backfill voids created by demolition (size of void = football field 90 feet deep)
    - Bulk Shipping (i e , 10 Yd Trucks w/pups)
    - Inert Material from approved source

Concrete Disposition Options

Total Removal w/Offsite Fill
Smart C&D



Criteria Comparison

Category	High	Med	Low
Worker Safety	□	■	□
Transportation	□	■	□
Budget Acceptance	■	□	□
Stakeholder Accepatance	■	□	□
Schedule Performance	□	■	□
Technology Feasibility	□	■	□

Smart C&D - All Off Site 7/28/97

Description

Combine characterization with decontamination, Demolish and remove entire structure, Low level waste to NTS, Demolition debris to off-site landfill (Erie)

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

Remove bulk contamination
11,550 MT - **$15 9M**
Decon Concrete entire structure to off-site free release 7,150 MT - **$39 3M**

Dispose of 16,325 CM Low Level Waste at NTS
cost **$7 5M**

Transportation

1,033 trips Low Level
1,550,000 miles
11,555 trips sanitary
920,000 miles

10,522 trips backfill
420,000 miles

23,110 Total trips
2,900,000 miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = **$46M**

Dispose of 210,300 MT demolition debris at off-site sanitary landfill (Erie)
cost **$7.8M**

Fill voids to grade with suitable fill material 121,000 CM
cost = **$1 2M**

Estimated costs

Low level waste $15 9 (bulk) + $39 3M (scabble) + $7 5M (disposal) = $63 7M
Sanitary waste $46M (demo) + $7 8M (disposal) + $1 2M (backfill) = $55M
Total = $117 7M

Assumptions/Issues for discussion

Key

1 Combining characterization with decontamination would eliminated 2/3 of surface decontamination

Standard

1 30% of structure is located below grade
2 Total area to decon is 3 92M s ft (2 74M above grade, 1 18M below grade) @ $30/s ft
3 Release limit and criteria have been established for free release of concrete to public landfill
4 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
5 30% of floor space associated with basements (8 ft wall), yields 121,000 CM void
6 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
7 Sanitary waste disposal costs = $84/CM ($40 disposal, $44 transportation)
8 Backfill for building voids purchased from vendor @ $10/CM
9 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
10 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 8 SMART C&D - ALL OFF SITE

ASSUMPTIONS:

1) SCABBLING REDUCED TO 1/3 BASE

2) REMOVE SOLID CONTAMINATION PRIOR TO SCABBLING

LL GENERATION:

SOLID = 11550 MT = $15.9 M

SCABBLE = 21,450 MT · 1/3 = 7150 MT @ $5500/MT = $39.3 M

LL DISPOSAL: 11,550 MT + 7150 MT = 18,700 MT

18,700 MT (.873 CM/MT) = 16,325 CM

16,325 CM @ $460/CM = $7.5 M

TRUCKS = 16,325 CM / 15.8 CM/TRIP = 1033 TRIPS

SANITARY: GENERATION = $46 M

DISPOSAL = 196,000 MT + [33,000 MT − 18700 MT] = 210,300 MT

@ $37/MT = $7.8 M

TRUCKS = 210,300 MT / 18.2 = 11,555 TRIPS

BACKFILL $1.2 M 10,522 TRIPS

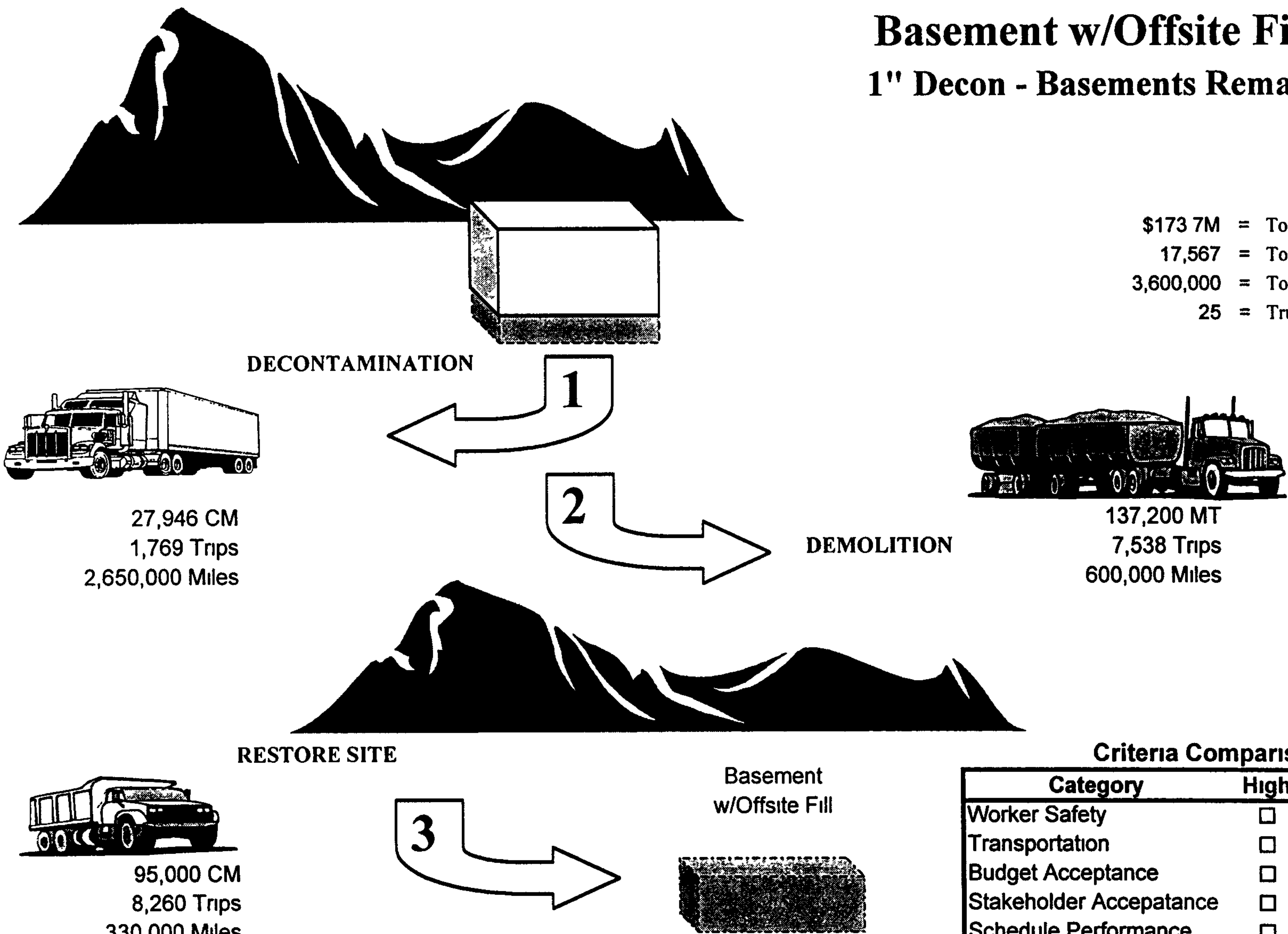
TOTAL = $117.7 M & 23,110 TRIPS

Concrete Disposition Options

Basement w/Offsite Fill

1" Decon - Basements Remain

$173 7M = Total Cost
17,567 = Total Trips
3,600,000 = Total Miles
25 = Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	□	□	■
Transportation	□	■	□
Budget Acceptance	□	■	□
Stakeholder Accepatance	□	■	□
Schedule Performance	□	□	■
Technology Feasibility	■	□	□

1" Decon - Basements Remain 7/28/97

Description

Decon buildings, Demolish and remove above grade structures only, Below grade structures remain in place

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

Remove bulk contamination
11,204 MT - **$15 4M**
Decon Concrete above grade to off-site release, below grade to on-site release
20,807 MT - **$114 5M**

Dispose of 27,946 CM Low Level Waste at NTS
cost $12 9M

Transportation

1,769 trips Low Level
2,650,000 miles
7,538 trips sanitary
600,000 miles

8,260 trips backfill
330,000 miles

17,567 Total trips
3,600,000 miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = $24 8M

Dispose of 137,200 MT demolition debris at off-site sanitary landfill (Erie)
cost $5.1M

Fill voids to grade with suitable fill material 95,000 CM
cost = $1M

Estimated costs

Low level waste $15 4 (bulk) + $114 5M (scabble) + $12 9M (disposal) = $142 8M
Sanitary waste $24 8M (demo) + $5 1M (disposal) + $1M (backfill) = $30 9M
Total = $173 7M

Assumptions/Issues for discussion

Key

1 Release limit and criteria have been established for on-site release of concrete
2 The on-site release criteria would result in 10% less material being removed compared to free release

Standard

1 Removing 1" of all interior surfaces gains free release of remaining structure
2 30% of structure is located below grade
3 Total area to decon is 3 92M s ft (2 74M above grade, 1 18M below grade) @ $30/s ft
4 Release limit and criteria have been established for free release of concrete to public landfill
5 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
6 30% of floor space associated with basements (8 ft wall), yields 121,000 CM void
7 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
8 Sanitary waste disposal costs = $84/CM ($40 disposal, $44 transportation)
9 Backfill for building voids purchased from vendor @ $10/CM
10 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
11 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 2 REMOVE SOLID CONTAMINATION

DECON 1" INTERIOR

• BASEMENTS STAY - ALL ELSE OFF SITE

ASSUMPTIONS'

1) ON-SITE RELEASE RESULTS IN 10% LESS MATERIAL REMO

• L.L. GENERATION:

BELOW GRADE: SOLID = (3465 MT)(.9) = 3119 MT @ $1375 = $4.3

SCABBLE = (6435 MT)(.9) = 5792 MT @ $5500/MT = $31.9 M

BELOW GRADE BASE = 9900 MT - AVOIDANCE = (9900 - (3119+5792)) = 990 MT (10%

ABOVE GRADE: SOLID = 8085 MT · $1375 = $11.1 M

SCABBLE = 15,015 MT · $5500/MT = $82.6 M

TOTAL = 4.3 + 31.9 + 11.1 + 82.6 = $129.9 M

• L.L DISPOSAL = [(9,900)(.9) + 23,100] MT = 32,011 MT

32,011 MT · .873 CM/MT = 27,946 CM @ $460/CM = $12.9 M

• TRUCKS = 27,946 CM / 15.8 CM/TRIP = 1769 TRUCKS

• SANITARY GENERATION = $24.8M ABOVE

• SANITARY DISPOSAL = (196,000)(.7) = 137,200 MT

@ $37/MT = $5.1 M

• TRUCKS = 137,200 MT / 18.2 MT/TRIP = 7538 TRIPS

BACKFILL = (121,000 CM - [[(.3)(196,000) + 990) MT · 2200 lb/MT / 3900 lb/yd³] ÷ 1308

= 121,000 CM - 26,000 = 95,000 CM

@ $10/CM = $1 M

TRUCKS = 95000 CM / 11.5 CM/TRIP = 8260

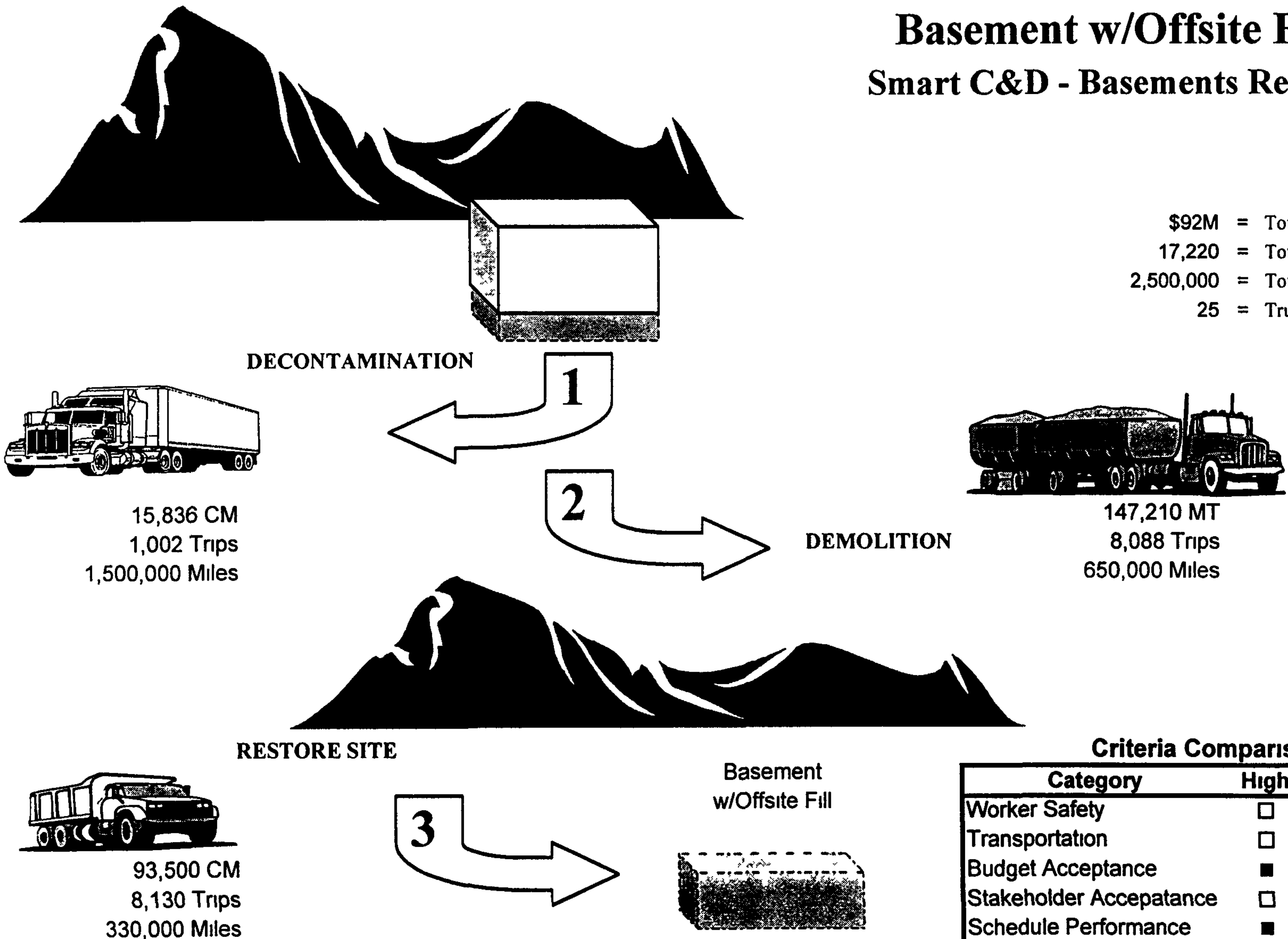
TOTAL = $173.7 M TRIPS = 17567

Concrete Disposition Options

Basement w/Offsite Fill

Smart C&D - Basements Remain

$92M = Total Cost
17,220 = Total Trips
2,500,000 = Total Miles
25 = Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	□	■	□
Transportation	□	■	□
Budget Acceptance	■	□	□
Stakeholder Accepatance	□	■	□
Schedule Performance	■	□	□
Technology Feasibility	□	■	□

Smart C & D - Basements Remain 7/28/97

Description
Combine characterization with decontamination, Demolish and remove above grade structures only, below grade structures remain

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

Remove bulk contamination
11,204 MT - $15 4M
Decon Concrete above grade to off-site release, below grade to on-site release 6,936 MT - $38.1M

Dispose of 15,836 CM Low Level Waste at NTS
cost $7.3M

Transportation

1,002 trips Low Level
1,500,000 miles
8,088 trips sanitary
650,000 miles

8,130 trips backfill
330,000 miles

17,220 Total trips
2,500,000 miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = $24.8M

Dispose of 147,210 MT demolition debris at off-site sanitary landfill (Erie)
cost $5 5M

Fill voids to grade with suitable fill material 93,500 CM
cost = $ 9M

Estimated costs

Low level waste $15 4 (bulk) + $38 1M (scabble) + $7 3M (disposal) = $60 8M
Sanitary waste $24 8M (demo) + $5 5M (disposal) + $ 9M (backfill) = $31 2M
Total = $92M

Assumptions/Issues for discussion
Key
1 Combining characterization with decontamination would eliminated 2/3 of surface decontamination
2 Release limit and criteria have been established for on-site release of concrete
3 The on-site release criteria would result in 10% less material being removed compared to free release

Standard
1 30% of structure is located below grade
2 Total area to decon is 3 92M s ft (2 74M above grade, 1 18M below grade) @ $30/s ft
3 Release limit and criteria have been established for free release of concrete to public landfill
4 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
5 30% of floor space associated with basements (8 ft wall), yields 121,000 CM void
6 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
7 Sanitary waste disposal costs = $84/CM ($40 disposal, $44 transportation)
8 Backfill for building voids purchased from vendor @ $10/CM
9 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
10 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 9a SMART C&D BASEMENTS REMAIN

ASSUMPTIONS:

1) SMART C&D REDUCES MATERIAL REMOVAL TO 1/3 BASE
2) ON-SITE RELEASE REDUCES MATERIAL REMOVAL 10%
3) SOLID CONTAMINATION REMOVED PRIOR TO SCABBLING

• L.L. GENERATION:

BELOW GRADE: SOLID = (3465 MT)(.9) = 3119 MT @ $1375 = $4.3 M

SCABBLE = 1/3(6435 MT)(.9) = 1931 MT @ $5500 MT = $10.6

ABOVE GRADE: SOLID • 8085 MT • $1375 = $11.1 M

SCABBLE • 1/3(15,015 MT @ $5500/MT) = $27.5M

SOLID = $15.4 M   SCABBLE = $38.1 M   TOTAL = $53.5

• L.L. DISPOSAL:

VOL. ⇒ 3119 + 1931 + 8085 + 5,005 = 18,140 MT

18,140 MT • (873 CM/MT) = 15,836 CM

15,836 CM • $460/CM = $7.3 M

TRUCKS = 15,836 / 15.8 CM/TRIP = 1,002 TRIPS

• SANITARY GENERATION: $24.8 M

SANITARY DISPOSAL: (196,000)(.7) = 137,200 MT + 2/3 (15,015) MT

= 147,210 MT

@ $37/MT = $5.5 M

TRUCKS = 147,210 MT / 182 = 8,088 TRIPS

• BACKFILL (121,000 CM) − [.3(196,000 MT) + (9900 − (3119 + 1931))] 2200 lb/MT ÷ 3900 lb/yd³ ÷

= 121,000 CM − 27,500

= 93,500 CM

@ $10/CM = $.9M

TRUCKS = 93500/11.5 = 8,130 TRUCKS

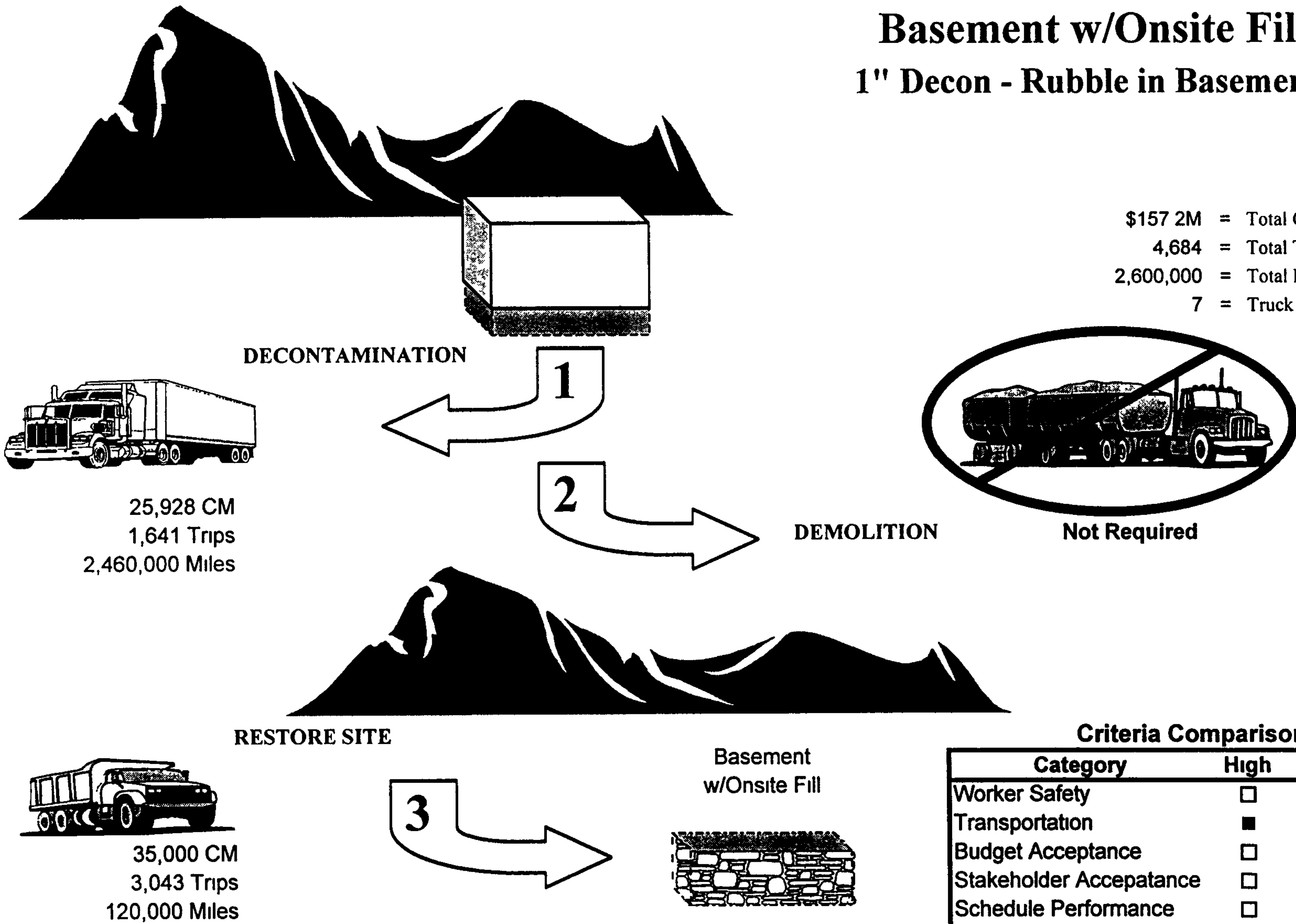
TOTAL = $92 M   TRIPS = 17,220

Concrete Disposition Options

Basement w/Onsite Fill

1" Decon - Rubble in Basements

$157 2M	=	Total Cost
4,684	=	Total Trips
2,600,000	=	Total Miles
7	=	Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	□	□	■
Transportation	■	□	□
Budget Acceptance	□	■	□
Stakeholder Accepatance	□	□	■
Schedule Performance	□	■	□
Technology Feasibility	■	□	□

1" Decon - Basements with On Site Fill 7/28/97

Description

Decon structures, Demolish above grade structures, Utilize rubble as backfill in basements

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

Remove bulk contamination
10,395 MT - **$14 3M**
Decon Concrete entire structure to on-site free release 19,305 MT - **$105.8M**

Dispose of 25,928 CM Low Level Waste at NTS
cost **$11 9M**

Transportation

1,641 trips Low Level
2,460,000 miles
0 trips sanitary
0 miles

3,043 trips backfill
120,000 miles

4,684 Total trips
2,600,000miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = $24 8M

No Sanitary Disposal

Fill voids to grade with suitable fill material 35,000 CM
cost = $ 4M

Estimated costs

Low level waste $14 3 (bulk) + $105 8M (scabble) + $11 9M (disposal) = $132M
Sanitary waste $24 8M (demo) + $0 (disposal) + $ 4M (backfill) = $25 2M
Total = **$157 2M**

Assumptions/Issues for discussion

Key

1 Release limit and criteria have been established for on-site release of concrete
2 The on-site release criteria would result in 10% less material being removed compared to free release

Standard

1 Removing ≤1" of all interior surfaces gains on-site release of remaining structure
2 30% of structure is located below grade
3 Total area to decon is 3 92M s ft (2 74M above grade, 1 18M below grade) @ $30/s ft
4 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
5 30% of floor space associated with basements (8 ft wall), yields 121,000 CM void
6 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
7 Backfill for building voids purchased from vendor @ $10/CM
8 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
9 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 3 REMOVE SOLID CONTAMINATION
DECON 1" INTERIOR SURFACES
· RUBBLE IN BASEMENTS

ASSUMPTION: ON-SITE RELEASE RESULTS IN 10% MATERIAL REMOV.

· LL GENERATION.

BASE = $117.6 M SCABBLE @ -10% = $105.8 M
$15.9 M SOLID @ -10% = $14.3 M

TOTAL = $120.1 M

LL. DISPOSAL = 33,000 MT @ -10% = 29700 MT (3300 REMAIN)
29700 MT × .873 CM/MT = 25,928 CM
@ $460/CM = $11.9 M

TRUCKS = 25928 CM / 15.8 CM/TRIP = 1,641 TRIPS

· SANITARY GENERATION: = $24.8 ABOVE

· SANITARY DISPOSAL: ($0)

VOLUME = 229,000 MT − 29,700 MT
= 199,300 MT

$199{,}300\ \text{MT} \times \frac{2200\ \text{lb/MT}}{3900\ \text{lb/yd}^3} \div (1.308\ \text{yd/cm}) = 85{,}952\ \text{CM}$

· BACKFILL = 121,000 CM − 86,000 CM = 35,000 CM
@ $10/CM = $.4 M

TRUCKS = 35,000 / 11.5 CM/TRIP = 3,043 TRIPS

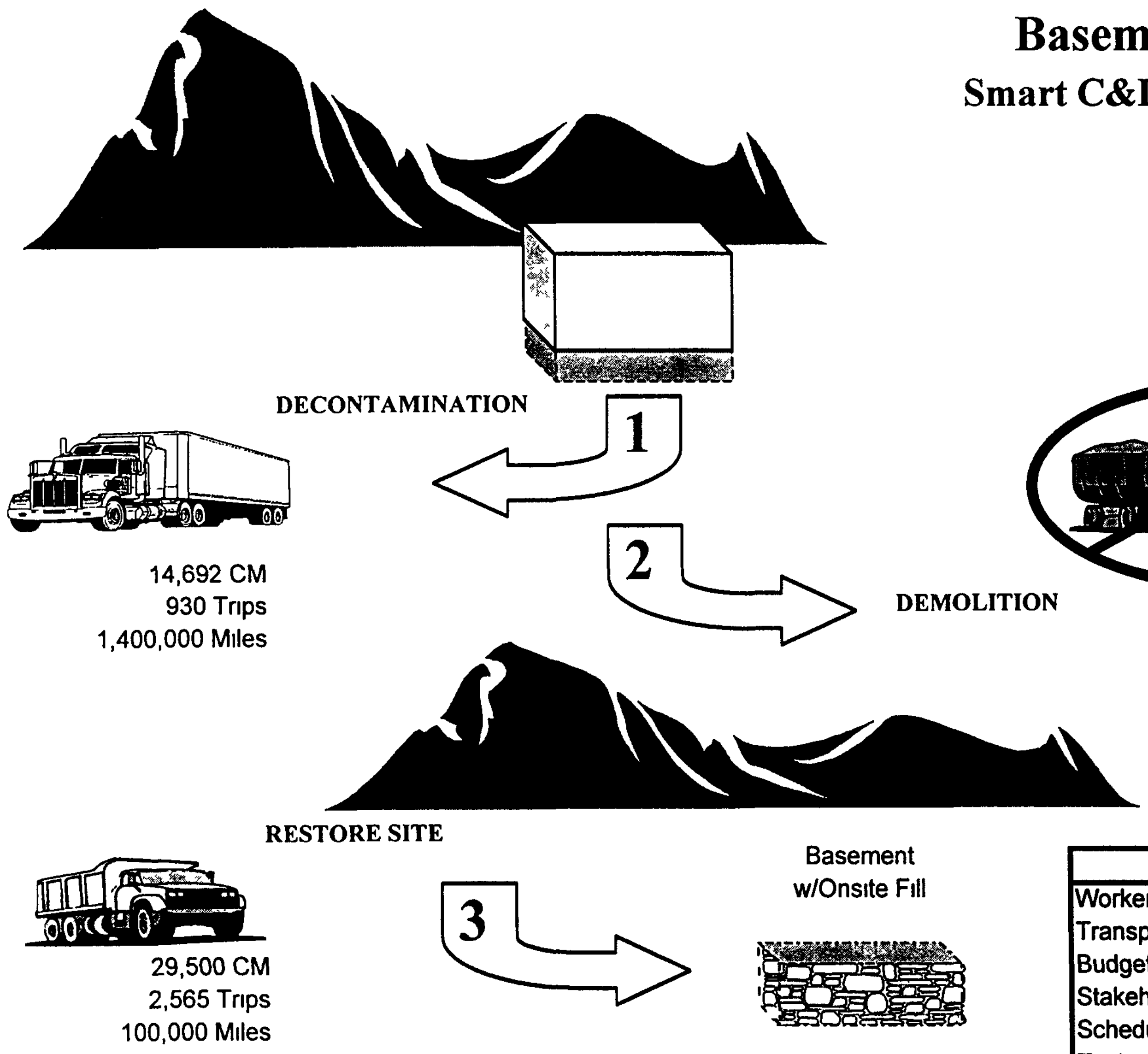
TOTAL = $157.2 M TRUCKS = 4,684

Concrete Disposition Options

Basement w/Onsite Fill

Smart C&D - Rubble in Basements

$81 6M = Total Cost
3,495 = Total Trips
1,500,000 = Total Miles
5 = Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	☐	■	☐
Transportation	■	☐	☐
Budget Acceptance	■	☐	☐
Stakeholder Accepatance	☐	☐	■
Schedule Performance	■	☐	☐
Technology Feasibility	☐	■	☐

Smart C & D - Basements with On Site Fill 7/28/97

Description
Combine characterization with decontamination, Demolish above grade structures, Utilize rubble as backfill in basements

	Structural Concrete on Site 196,000 MT Sanitary 33,000 MT Low Level	
Low Level Waste		**Sanitary Waste**
Remove bulk contamination 10,395 MT - **$14 3M** Decon Concrete entire structure to on-site free release 6435 MT - **$35 4M**		Demolish and remove entire structure (above and below grade) **cost = $24 8M**
	Transportation	
Dispose of 14,692 CM Low Level Waste at NTS **cost $6 8M**	930 trips Low Level 1,400,000 miles 0 trips sanitary 0 miles	No Sanitary Disposal
	2,565 trips backfill 100,000 miles	Fill voids to grade with suitable fill material 29,500 CM **cost = $ 3M**
	3,495 Total trips **1,500,000 miles**	

Estimated costs

Low level waste $14 3 (bulk) + $35 4M (scabble) + $6 8M (disposal) = $56 5M
Sanitary waste $24 8M (demo) + $0 (disposal) + $ 3M (backfill) = $25 1M
Total = **$81 6M**

Assumptions/Issues for discussion

Key

1 Combining characterization with decontamination would eliminated 2/3 of surface decontamination
2 Release limit and criteria have been established for on-site release of concrete
3 The on-site release criteria would result in 10% less material being removed compared to free release

Standard·

1 30% of structure is located below grade
2 Total area to decon is 3 92M s ft (2 74M above grade, 1 18M below grade) @ $30/s ft
3 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
4 30% of floor space associated with basements (8 ft wall), yields 121,000 CM void
5 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
6 Backfill for building voids purchased from vendor @ $10/CM
7 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
8 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

9) SMART C&D RUBBLE FILL

ASSUMPTIONS:

1) SMART C&D RESULTS IN 1/3 SCABBLING & WASTE GENERATION

2) ON-SITE RELEASE RESULTS IN 10% REDUCTION IN MATERIAL REMOVAL

3) SOLID CONTAMINATION REMOVED PRIOR TO DECON

• L.L GENERATION

SOLID REMOVAL = 11,550 MT (.9) = 10,395 MT @ $1375/MT • $14.3 M

SCABBLE = (21,450 MT)(.9)(1/3) = 6435 MT @ $5500/MT = $35.4 M

• L.L. DISPOSAL = (6435 MT + 10,395 MT) = 16830 MT

16830 MT • .873 CM/MT = 14,692 CM

@ $460/CM = $6.8 M

TRUCKS = 14,692 CM / 15.8 CM/TRIP = 930 TRIPS

• SANITARY GENERATION = $24.8 M

DISPOSAL = Ø

VOLUME = 229,000 MT − 16830 MT = 212,170 MT

• BACKFILL − ON SITE = 212,170 MT · 2200 lb/MT / 3900 lb/yd ÷ 1.308

= 91,500 CM

121,000 CM − 91,500 CM = 29,500 CM

@ $10/CM = $.3 M

TRUCKS = 29,500 / 11.5 CM/TRIP = 2565 TRIPS

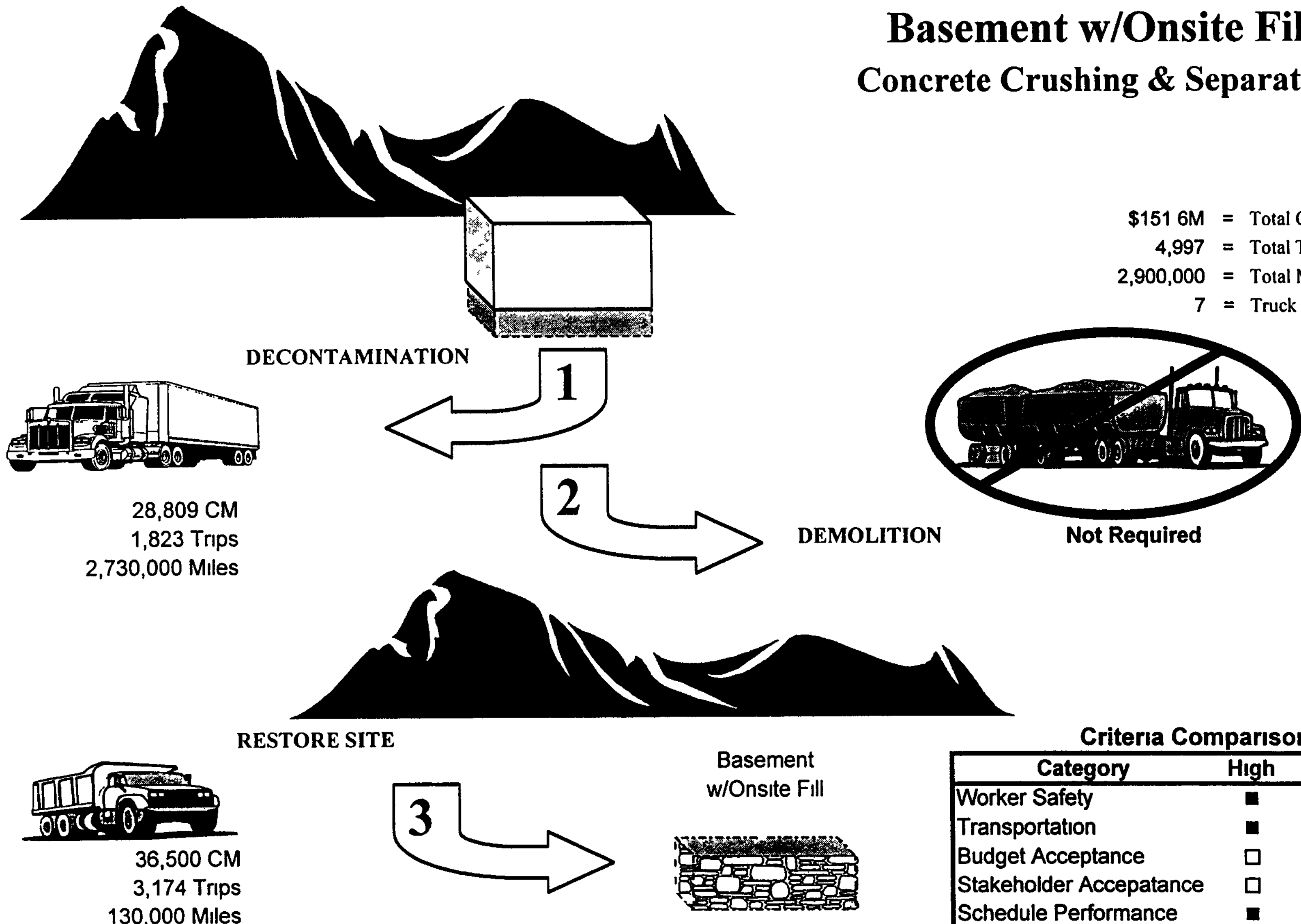
TOTAL = $81.6 M TRIPS = 3495 TRIPS

Concrete Disposition Options

Basement w/Onsite Fill

Concrete Crushing & Separation

$151 6M = Total Cost
4,997 = Total Trips
2,900,000 = Total Miles
7 = Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	■	□	□
Transportation	■	□	□
Budget Acceptance	□	■	□
Stakeholder Accepatance	□	■	□
Schedule Performance	■	□	□
Technology Feasibility	□	□	■

Crush and Separate - 7/28/97

Description
Demolish entire structure as low level waste, process waste through crushing system employing separations, utilize clean processed material as backfill

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

Remove bulk contamination
11,550 MT - **$15 9M**
Decon by crushing concrete and segregating 21,450 MT
cost = $30M

Dispose of
28,809 CM Low Level Waste at NTS
cost $13 3M

Transportation

1,823 trips Low Level
2,730,000 miles
0 trips sanitary

3,174 trips backfill
130,000 miles

4,997 Total trips
2,900,000 miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = $92

No sanitary waste

Fill voids to grade with suitable fill material 36,500CM
cost = $ 4M

Estimated costs

Low level waste $15 9 (bulk) + $30M (crush/separate) + $13 3M (disposal) = $59 2M
Sanitary waste $92M (demo) + $0 (disposal) + $ 4M (backfill) = $92 4M
Total = **$151 6M**

Assumptions/Issues for discussion
Key
1 A contaminated concrete recycling system has not been developed An ICF-Kaiser VE study (7/97) determined that the system was feasible for the Mound Site (total cost, including 5 yr operations $8 5M) but did not analyze the system in detail for Pu separations The $30M assumed cost was used to account for the extra sensors/longer scan time for Pu
2 Reduced characterization and elimination of release survey costs not considered
3 Demolition costs doubled over baseline to account for low level waste
Standard
1 35% low level contaminated concrete removed in bulk form (i e saw cut) prior to scabbling
2 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
3 30% of floor space associated with basements (8 ft wall), yielding 121,000 CM void
4 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
5 Backfill for building voids purchased from vendor @ $10/CM
6 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
7 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

Crush and Separate Best Case (Smart C & D)- 7/28/97

Description
Demolish entire structure as low level waste, process waste through crushing system employing separations, utilize clean processed material as backfill

Low Level Waste	Transportation	Sanitary Waste
	Structural Concrete on Site 196,000 MT Sanitary 33,000 MT Low Level	
Remove bulk contamination 10,395 MT - **$14 3M** Decon by crushing concrete and segregating 6,435 MT **cost = $30M**		Demolish and remove entire structure (above and below grade) **cost = $92**
Dispose of 14,693 CM Low Level Waste at NTS **cost $6 8M**	930 trips Low Level 1,400,000 miles 0 trips sanitary	No sanitary waste
	2,565 trips backfill 100,000 miles	Fill voids to grade with suitable fill material 29,500 CM **cost = $ 3M**
	3,495 Total trips **1,500,000 miles**	

Estimated costs
Low level waste $14 3 (bulk) + $30M (crush/separate) + $6 8M (disposal) = $51 1M
Sanitary waste $92M (demo) + $0 (disposal) + $ 3M (backfill) = $92 3M
Total = **$143 3M**

Assumptions/Issues for discussion
Key
1 A contaminated concrete recycling system has not been developed An ICF-Kaiser VE study (7/97) determined that the system was feasible for the Mound Site (total cost, including 5 yr operations $8 5M) but did not analyze the system in detail for Pu separations The $30M assumed cost was used to account for the extra sensors/longer scan time for Pu
2 Reduced characterization and elimination of release survey costs not considered
3 Demolition costs doubled over baseline to account for low level waste
4 Combining characterization with decontamination would eliminated 2/3 of surface decontamination
5 Release limit and criteria have been established for on-site release of concrete
6 The on-site release criteria would result in 10% less material being removed compared to free release
Standard
1 35% low level contaminated concrete removed in bulk form (i e saw cut) prior to scabbling
2 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
3 30% of floor space associated with basements (8 ft wall), yielding 121,000 CM void
4 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
5 Backfill for building voids purchased from vendor @ $10/CM
6 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
7 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 10 CRUSH & SEPARATE

ASSUMPTIONS:

1) REMOVE SOLID CONTAMINATION PRIOR TO DEMO AND PROCESSING

• LL GENERATION:

SOLID: 11,550 MT ($1375/MT) = $15.9 M

CRUSH & SEPARATE @ $30M

PRODUCE 21,450 MT

• LL DISPOSAL: 33,000 MT (.873 CM/MT) = 28,809 CM

28809 @ $460/CM = $13.3 M

• TRIPS = 28,809 CM / 15.8 CM/TRIP = 1823 TRIPS

• SANITARY GENERATION = $92 M

BACKFILL = 121,000 CM − [196,000 MT · $\frac{2200 \text{ lb/MT}}{3900 \text{ lb/yd}^3}$] ÷ 1.308 yd/CM

= 36,500 CM

@ $10/CM = $.4 M

• TRUCKS = 36500 / 11.5 = 3174 TRIPS

TOTAL = $151.6 M 4997 TRIPS

CONCRETE CRUSHING – RECYCLING OPTION

Scope:

Process concrete demolition debris on-site into a usable aggregate type product

Advantages:

The main advantage to recycling in general is the reduction of waste and preservation of natural resources Potential cost savings can be achieved through recycling concrete at Rocky Flats by 1) elimination of concrete disposal costs, 2) reduced need for purchasing similar material needed for site closure (backfill material, cap material) 3) reduced transportation costs and associated safety hazards, and 4) recover scrap steel for recycling Another significant advantage to on-site recycling is the avoidance of establishing and obtaining an off-site free release determination for the concrete

Concrete recycling estimate:

Crushing costs are dependent on several factors The three main variables are material input size, aggregate output size, and rebar quantity Two cost estimates were obtained, best case and worst case Best case is for a standard reinforced "chunk", 18"-24" size, with no protruding rebar (approx **$4/ton**) Typical demolition rubble consists of much larger sized debris containing miscellaneous attached reinforcements and protruding rebar This adds approximately $1/ton cost for "pre-sizing" the material (burning off steel/rebar, downsizing rubble with crushing attachment) Therefore, for option analysis, a **$5/ton ($5.50/MT)** cost was used This will produce, in a single pass, an approximate 2 ½" - 3" minus (non-spec) material For an additional $0 75/ton, the material can be screened to provide specific sized aggregate

Note Crushing cost estimates were obtained from Mr Rick Givin, Project Manager/Estimator, Recycled Materials Company, Inc , Arvada Colorado, (303)431-3701 The costs provided are *rough industry estimates* to be used for option analysis only The estimates quoted do not reflect mobilization to the Rocky Flats site or ***any other site-specific requirements***

Conversion factors 1 308 cu yd/CM, 2200 lb /MT
Unit weights Solid concrete = 3900 lb /cu yd = 2 31 MT/CM
Gravel = 3000 lb/cu yd = 1 78 MT/CM

Cost Comparisons.

Scenario #1

<u>Baseline disposal estimate (1" Decon- All off-site)</u>

1 Backfill requirements = 121,000 CM @ $10/CM = $1,210,000
Truck trips to site = 10,500
Total round trip miles = 420,000

2 Disposal requirements = 196,000 MT @ $37/MT = $7,250,000
Truck trips from site = 10,769
Total round trip miles = 860,000

Baseline total (off-site disposal, purchase fill material) = <u>$8,460,000 1,280,000 miles</u>

<u>Concrete recycling</u>
1 196,000 MT @ $5 50/MT = $1,080,000
@ $11/MT = $2,160,000
@ $16 5/MT = $3,230,000
No off-site truck travel

2 196,000 MT gravel = 110,000 CM gravel
No off-site truck travel

<u>Comparison</u>
Crushing the concrete debris produces 110,000 CM gravel, leaving 11,000 CM backfill material to purchase 11,000 CM @ $10/CM = $110,000
Total trips = 11,000 CM/11 5 CM/trip = 957 trips
Total miles = 40 miles trip x 957 trips = 38,280 miles

Total crushing costs @ $5 50/MT $1,080,000 + $110,000 = <u>$1,190,000 - 38,280 miles</u>

Net savings @ $5.50/MT = $7,270,000 - 1,242,000 miles avoided
@ $11/MT = $6,190,000 - 1,242,000 miles avoided
@ $16.5/MT = $5,120,000 - 1,242,000 miles avoided

Scenario #2:
<u>Baseline disposal estimate (Smart C&D – all offsite)</u>
1 Backfill requirements = 121,000 CM @ $10/CM = $1,210,000
Truck trips to site = 10,500
Total round trip miles = 420,000

2 Disposal requirements = 210,300 MT @ $37/MT = $7,780,000
Truck trips from site = 11,555
Total round trip miles = 920,000

Baseline total (off-site disposal, purchase fill material) = <u>$8,990,000 1,340,000 miles</u>

<u>Concrete recycling</u>
1 210,300 MT @ $5 50/MT = $1,160,000
@ $11/MT = $2,310,000
@ $16 5/MT = $3,470,000
No off-site truck travel

2 210,300 MT gravel = 118,000 CM gravel
Purchase 3,000 CM backfill $30,000 - 261 trips - 10,440 miles

Total crushing costs @ $5 50/MT $1,160,000 + $30,000 = $1,190,000 - 10,440 miles

Net savings @ $5.50/MT = $7,800,000 - 1,330,000 miles avoided
@ $11/MT = $6,650,000 - 1,330,000 miles avoided
@ $16.5/MT = $5,490,000 - 1,330,000 miles avoided

Summary:

Using general industry estimates for concrete recycling costs, there is a potential to save roughly $5M to $7M depending on actual on-site costs compared to industry standard rates, and eliminate over 1,200,000 miles of off-site truck travel Recycling concrete at Rocky Flats remains an economically feasible option at a unit rate up to 7 times the standard industry rate of $5 50/MT ($38 50/MT), based on previous estimated disposal costs

RECYCLED MATERIALS COMPANY

Recycled Materials Company, Inc
and
Recycled Materials Consulting, Inc
6385 W 52nd Avenue
Arvada, Colorado 80001 U S A
(303)431-3701

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On-Site Mobile Recycling

Urban Recycling Centers

Technical Assistance/ Consulting

On-Site Mobile Recycling

Recycled Materials Company makes specification aggregates We can make the sized or densely graded aggregates you require right on your project

Why mobile recycling? There are many benefits to on-site recycling services

- It saves the cost of hauling rubble off-site
- It saves the cost of importing aggregate
- It reduces local truck traffic and congestion

How much does it cost? Several factors need to be considered When analyzing potential project savings, including haul costs to alternative disposal sites, the quantity of aggregate required in the project, aggregate costs and the haul distance/cost of required aggregates

Tracked Jaw Crusher - Able to break even steel-reinforced concrete!

For more information, call us at (303)431-3701 We will be happy to answer your questions

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CONTACT. RICK GIVIN - ESTIMATOR 9-9-98

City of Fort Collins, Colorado

Natural Resources Department

Construction, Demolition Debris

- **Hageman Earth Cycle**, located at 3501 E Prospect, accepts clean construction wood waste (scrap lumber, crates, pallets, shake shingles), 221-7173, located at 3501 E Prospect Road No cement, sheetrock, carpet remnants, etc Fee charged per cubic yard

- **Allied Recycled Aggregates**, Commerce City, 303-289-3366 7901 Highway 285, concrete and asphalt Used lumber available

- **Brothers Redevelopment**, Denver, 303-296-8580 Good quality used construction material only, for reuse

- **Construction Endeavors**, Colorado Springs, 2255 E Las Vegas, 303-375-0785 Asphalt, concrete, grass, sod, and wood

- **Construction Recycling Inc** , Erie, 3220 Weld County Rd 8, 303-440-8777, 303-828-3410 Demolition debris, pallets, wood waste, trees, branches & stumps, concrete and asphalt

- **Habitat for Humanity**, 221-1104, Fort Collins

- **Oxford Recycling, Englewood**, 2400 W Oxford Ave , 303-762-1160 Accepts concrete, asphalt, wood products and tires

- **Recycled Materials Company**, Arvada, 5500 Fenton, 303-423-2736 Asphalt and concrete

- **Western Mobile**, Boulder, 303-444-6320 Concrete and asphalt

- **Western Mobile**, Fort Collins, 482-7854 Clean concrete

BACK

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Last Revised ***Wednesday, October 15, 1997 16 16 54***

CONTAMINATED CONCRETE RECYCLING SYSTEM

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INTRODUCTION

The Contaminated Concrete Recycling System integrates existing technologies into a contaminated concrete crushing and separating system that would

(1) Provide a process to reduce the volume of concrete waste generated by decontamination, decommissioning, and demolition activities, and

(2) Yield large quantities of potentially reusable and recyclable concrete aggregate and steel

This concept was initially developed in a Feasibility Study completed in August of 1996, for the U S Department of Energy (DOE)

The recommendations of the feasibility study included performing a Value Engineering Study to define the components required and potential benefits of a concrete crushing and separating system The Contaminated Concrete Recycling System Value Engineering (VE) Study was conducted for the DOE on June 23 - 27, 1997 in Dayton, Ohio

The VE Study focused on two DOE sites, Fernald and Mound, as the basis for defining requirements and potential benefits of applying the Contaminated Concrete Recycling System While disposal methods vary from site to site, these two sites are generally representative of concrete and reinforcing steel disposal needs throughout the DOE complex Currently, the Fernald site plans to dispose of generated wastes in an onsite disposal facility and the Mound site plans to ship wastes offsite

This paper presents an overview of the combined findings, conclusions and recommendations of the Feasibility and Value Engineering studies

Problem Statement

There are over 6,000 contaminated buildings within the DOE complex that require decontamination, decommissioning, and final disposition In general, concrete will make up the largest volume waste stream from these activities The estimated concrete volumes generated from these buildings will be more than 23,000,000 cubic meters This includes contaminated and potentially contaminated concrete with varying levels of reinforcing steel internally imbedded

As decontamination, decommissioning, and demolition efforts progress, the DOE will be faced with disposing of these vast amounts of contaminated concrete Using current practices, nearly all of this volume of concrete will be dealt with as contaminated waste, simply because unknown quantities of potentially contaminated concrete and steel remain after decommissioning due to cracks, expansion joints and other surface imperfections Disposition of this material as contaminated waste represents a significant cost and schedule driver for the DOE cleanup mission

In addition, the commercial nuclear industry has problems of similar character, both in the United States and world-wide

Proposed Solution

The Contaminated Concrete Recycling System can minimize the need for valuable waste disposal space, while yielding large quantities of potentially reusable concrete aggregate and steel

Waste volume reduction will be accomplished as large chunks of demolition rubble are crushed into smaller and more consistently sized aggregate, as steel is separated from the aggregate, and then as contaminated aggregate is separated from the 'clean' aggregate Initially, it is expected that the 'clean' aggregate will only be available for reuse onsite or in the making of disposal containers and fill material, but as capabilities are proven, the potential exists that verifiably clean aggregate and steel will be available for free release

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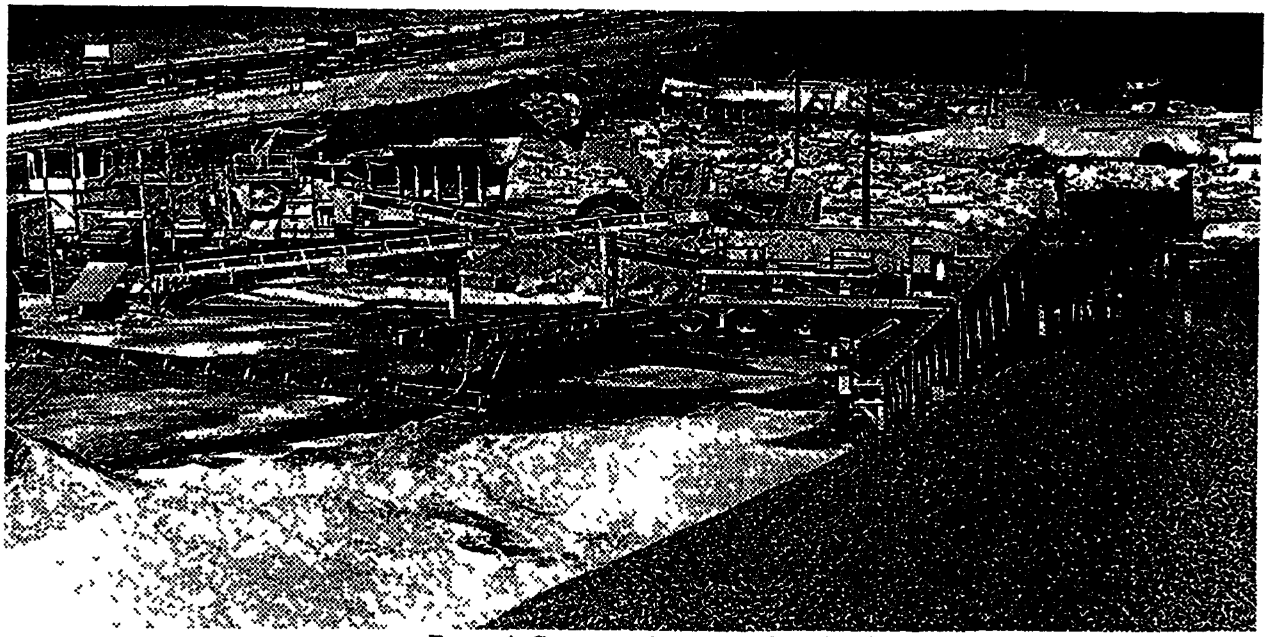

Figure 1, Commercial Concrete Recycling Plant

Potential Benefit

Since most radioactive contamination on concrete is relatively superficial, the quantities of re-useable and recyclable materials that could be separated from the waste stream are substantial A range of potential was assumed in the VE Study at 50% to 90% of the volume being recoverable Even at percentages well below this range, the potential volume of reduction and reuse across the DOE complex, would be in the millions of cubic yards

RESULTS OF STUDIES

Feasibility Study

The feasibility study found that nearly all relevant technologies and equipment are currently available, and that truly massive quantities of contaminated concrete must be dispositioned throughout the nuclear industry As such, it was concluded that developing a Contaminated Concrete Recycling System is possible and could save significant time, money, and natural resources

Value Engineering Study

The Value Engineering team for the Contaminated Concrete Crushing and Separating System was comprised of a range of industry experts from the fields of crusher design and operations magnetic separations, contaminated soil detection and separation systems, technology and project integration, environmental regulations, sensor technologies and capabilities, concrete recycling, federal nuclear site operations, federal nuclear site management, and Value Engineering processes

The objectives of the Value Engineering Study were to (1) Develop an equipment layout for the system, (2) Develop a cost estimate for the system, and (3) Determine the cost-benefit of using this system at two DOE sites Fernald and Mound

An overview of the products developed to meet each of these objectives are outlined below Detailed documentation of the Value Engineering session is available in the full VE study report

Detailed Equipment Layout

The Contaminated Concrete Recycle System consists of two primary operations -- crushing and separation

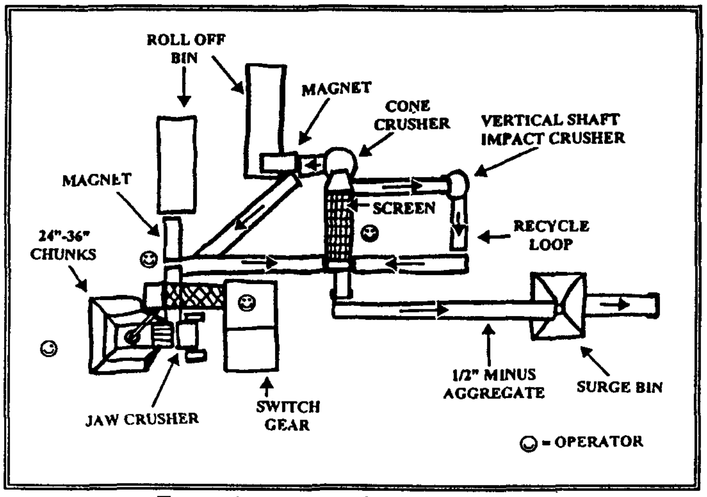

Figure 2, Concrete Crushing System

The crushing system is comprised of a staged system that reduces rubble down to a desired aggregate size, while removing metal from the concrete aggregate stream The first stage of this system uses a jaw crusher that reduces chunks of up to 36 inch diameters down to 4-6 inch aggregate, and metals are magnetically

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separated from the aggregate The second stage uses a cone crusher to reduce the 4-6 inch aggregate down to 1 5 inch minus aggregate, with a secondary magnetic separation of metals to assure full separation of concrete and steel If required, a third stage is used to reduce the 1 5 inch minus aggregate down to 0 5 inch minus aggregate This is accomplished with a vertical shaft impactor At this point all of the metallics have been removed, so no additional magnetics are required

Crushers and magnetic separators have been used in the construction and mining industries for many years Many varieties of portable and stationary crushers are available

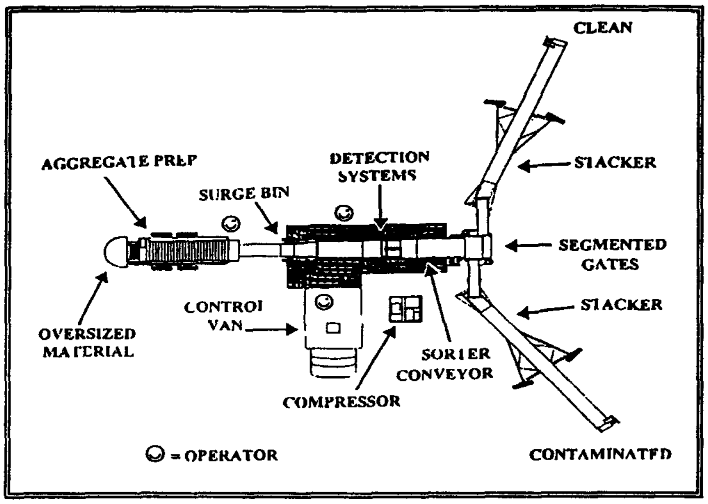

Figure 3, Segmented Gate

Separation of the aggregate is accomplished by using a Segmented Gate System (SGS) This operation involves conveying the sized aggregate from the crushing system into a feeder bin at the head end of the SGS This feeder spreads the aggregate onto a conveyor at a designated thickness The conveyor then passes the aggregate under a bank of radiation detection sensors, which can be adjusted or changed depending on the contaminates The information collected by the sensors is then feed by computer link to a gate system that separates the aggregate according to the contaminant limits required Conveyors then move the aggregate into separate storage areas

Segmented Gate Systems are currently being used for segregating contaminated soil Several projects involving contaminated soil have been completed or are in progress

Dust control is maintained during both of these operations through the use of misting systems and/or air handling and filter systems If required any separate portion or all of the operation can be enclosed in a greenhouse with negative air flow and filter systems in place

ACQUISITION COST ESTIMATE

The Value Engineering team developed two rough cost estimates for the acquisition, installation, and operation of the crushing and the separation systems Concept 1 estimates a crushing system only, for applications where bulk reduction, handling capabilities, and landfill compaction are a priority, such as the Fernald site Concept 2 estimates a full crushing and separation system for applications where volume reduction is a high priority, such as the Mound site and potentially the Fernald site

	Equipment Purchase Costs	Site Prep &Set Up	Operations[1]	Total Estimated Cost
Concept 1	$1,900,000	$200,000	$2,750,000	$4,850,000
(crushing only)				
Concept 2	$3,900,000	$250,000	$4,200,000	$8,350,000
(crushing and separations)				

Figure 4, Concept Costs

These rough estimates were developed as if the system were to be purchased and used by a single site exclusively over a five year period This represents the highest potential cost scenario, which provides a conservative basis for comparison against potential benefits There are a number of options to reduce these costs, (i e , multiple site uses over a longer time frame, performance contracts that minimize initial DOE outlay, applying life cycle costs and salvage values, etc), but for the purposes of the VE Study, this highest potential cost scenario was used

Cost Benefit Analysis - Fernald Site

The estimated volume of contaminated concrete at the Fernald site is 135,000 cubic meters (176,000 cubic yards) The baseline plan for disposal of this waste is to bury it onsite This will require placing large chunks of concrete rubble in the Onsite Disposal Facility (OSDF) landfill, and packing fines around these chunks in order to minimize voids and the potential for differential settling in the future

Based on using the Concept 1 system, crushing the contaminated concrete rubble down to 1 5 inch minus aggregate (which can then be mechanically dumped and spread within the landfill), an estimated cost avoidance of nearly $4 per cubic meter ($5 per cubic yard) can be achieved through bulk reduction and improved handling characteristics This equates to a total reduction of approximately $900,000 in baseline disposal costs, while significantly improving the expected long term performance and integrity of the disposal facility

Based on using the Concept 2 system, crushing the contaminated concrete rubble and separating the clean and contaminated aggregate and steel, a minimum estimated cost avoidance of $35 50 per cubic meter ($45 per cubic yard) can be achieved for each cubic meter of material that is taken out of the waste stream, which in turn reduces the required size of the OSDF This savings is in addition to the $4 per cubic meter ($5 per cubic yard) achieved through bulk reduction and improved handling characteristics for each cubic meter of material that is disposed of in the landfill At an assumed rate of 50% separation of 'clean' material from the waste stream, a total reduction of approximately

[1] 5 years straight costs no escalation and no interest

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$4,400,000 in baseline OSDF construction and disposal costs could be realized

A more optimistic calculation using the Concept 2 System the upper range of potential savings in OSDF construction costs (i e , $53 50 per cubic meter or $70 per cubic yard), and a 90% separation of 'clean' material produces a potential savings of $11,200,000

The conclusion drawn for the Fernald site is that to gain the landfill performance, integrity, and size reduction benefits of the crushing and separating systems, options must be explored to reduce the cost of acquiring the system by at least 25% Further discussion by the Value Engineering Team concluded that several viable options exist to accomplish this and there is a high probability of gaining the acquisition cost reductions

Cost Benefit Analysis - Mound Site

The estimated volume of contaminated concrete at the Mound site, which could be crushed and separated with today's proven technologies, is 30,000 cubic meters (40,000 cubic yards) An additional volume of 16,000 cubic meters (20,000 cubic yards) of concrete contaminated with tritium will be produced The tritium contaminated volume could be crushed to gain bulk reduction and disposal as soil However, the capability to separate these contaminants is not proven Currently sensing technologies for alpha emitters are still in the development and testing stages

The current baseline plan for disposing of this waste is to ship it for burial offsite The costs estimated for disposal are $64,000,000 if shipped to the Nevada Test Site (NTS) or $46,000,000 if shipped to Envirocare These costs include boxes (NTS only), packaging, shipping and disposal fees It is not expected that all will go to one location, but for the purposes of cost analysis these rough numbers are used for comparison to crushing and separating options

The fee for disposal of soils at Envirocare is $4 per cubic foot less than the fee at NTS and $11 per cubic foot less than the fee for rubble at the same Envirocare location Based on using a Concept 1 crusher system, that produces a soil specification aggregate, a mid-range estimate for disposal savings of $23,000,000, can be achieved from bulk reduction and substantially lower disposal fee

Based on using the Concept 2 system, for crushing all of the Mound site's projected contaminated concrete waste volume and the separation system for the non-alpha contaminated volumes will produce a combined disposal savings of $43,000,000 This is based on the bulk reduction and lower disposal fees gained through crushing and an assumed 50% volume reduction gained through separation

The conclusion drawn from this analysis was that even at much more conservative savings rates, both the crushing and separations systems could save substantial dollars

General Conclusion

The Contaminated Concrete Recycle System is fully feasible Existing systems and equipment are commercially available and in operation today For DOE or industry sites that must ship contaminated concrete rubble to offsite locations, the application of this system could produce significant cost savings For DOE or industry sites that will be disposing of contaminated concrete rubble in onsite disposal facilities, the application of this system could provide improved handling characteristics and significantly improving the expected long term performance and integrity of the disposal facility, at costs similar or slightly less than those projected

Even with the conservative nature of the cost assumptions used in the VE Study, the potential cost savings and performance benefits to be gained by the government through the application of the Contaminated Concrete Recycling System are substantial As such, it is recommended that either a prototype or full-scale project be developed and applied at a DOE site that will be generating contaminated concrete rubble

ACKNOWLEDGMENTS

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DRAFT 7/28/98

VOLUME ASSUMPTIONS

Conversion Factors

Metric ton (MT) = 2200 lb
Cubic meter (CM) = 1 308 cu yd

Unit Weight

Form of Concrete	Weight of 1 Cubic Yard
Solid, in place concrete	3900 lb
Concrete debris	3000 lb

Quantity Estimates (Data from Case 5-A waste volume matrix)

Functional Area	Total Sanitary Debris (MT)	Quantity used in estimate (MT)	Total Low Level Debris (MT)	Quantity used in estimate (MT)
Type 3	114,352	114,352	22,321	22,321
Other Production	55,114	27,557 (50%)	10,758	5,379 (50%)
Rest of Site	108,518	54,259 (50%)	10,591	5,296 (50%)
TOTAL		**196,168**		**32,996**

Sanitary volume

Solid volume 196,168 MT, at 3900 lb /yd, yields 110,658 cu yd , or **84,601 CM**
Bulking factor Estimate 30% growth in rubble yields **109,981 CM**

Low Level volume

Solid volume 32,996 MT, at 3900 lb /yd, yields 18,613 cu yd, or **14,230 CM**
Bulking factor Estimate 1MT yields 873CM packaged waste yields **28,805 CM**

ASSUMPTIONS

1 The primary construction material contained in Type 3 facilities is concrete, therefor 100% of the associated waste volume was included in the estimate

2 The non-Type 3 facilities contain approximately 50% concrete by volume

3 It is estimated that approximately 30% of the structural concrete is located at or below grade level

GENERAL ASSUMPTIONS:

GIVEN: 1) 196,000 MT SANITARY DEBRIS } ASSUMED IN SOLID FORM
2) 33,000 MT LOW LEVEL DEBRIS }

ASSUMPTIONS:

1) 35% LL REMOVED AS SOLID MASS
2) 65% LL. GENERATED BY SCABBLING 1" INTERIOR SURFACES
3) 30% STRUCTURAL CONCRETE BELOW GRADE
4) SOLID CONCRETE @ 3900 lb/yd^3
5) RUBBLE @ 3000 lb/yd^3
6) 1 MT CONCRETE = .873 CM LOW LEVEL PACKAGED WASTE

1) LOW LEVEL WASTE

a) BELOW GRADE = 30% (33,000 MT) = 9,900 MT
1) SOLID MASS = .35 (9,900) = 3465 MT
2) SCABBLE DEBRIS = .65 (9,900) = 6,435 MT

b) ABOVE GRADE = 33,000 − 9,900 = 23,100 MT
1) SOLID MASS = .35 (23,100) = 8,085 MT
2) SCABBLE DEBRIS = .65 (23,100) = 15,015 MT

TOTAL SOLID MASS REMOVAL = 11,550 MT

TOTAL DEBRIS (SCABBLE) = 21,450 MT

2) SCABBLING AREA

NOTE: ASSUME DEBRIS GENERATED BY SCABBLING 1 INCH

$(21,450 \text{ MT})(2200 \text{ lb/MT}) = 47.19 \text{ M lb.}$

$47.19 \text{ M lb} \div 3900 \text{ lb/yd}^3 = 12,100 \text{ yd}^3$

$(12,100 \text{ yd}^3)\cdot(27 \text{ ft}^3/\text{yd}^3) \div (1 \text{ in} \cdot 1 \text{ ft}/12 \text{ in}) = 3.92 \text{ M ft}^2$ TOTAL

ABOVE GRADE = 2.74 M ft^2

BELOW GRADE = 1.18 M ft^2

3.) DECON / SCABBLING COSTS

A) SCABBLING

ASSUMPTIONS:

1) SCABBLING 1" CONCRETE = $30/ft²

CALCULATIONS:

1) ABOVE GRADE = 2.74 M ft² · $30/ft² = **$82.2 M**

2.) BELOW GRADE = 1.18 M ft² · $30/ft² = **$35.4 M**

TOTAL = $117.6 M

⇒ $117.6M / 21,450 MT

= **$5500/MT**

B) SOLID REMOVAL

ASSUMPTIONS:

1) THIS METHOD COULD INLUDE WIRE CUTTING, JACK-HAMMER HEAVY EQUIPMENT REMOVAL, OR ANY OTHER METHOD OF LARGE VOLUME CONCRETE REMOVAL.

∴ ASSUME GENERATION COSTS = 25% SCABBLING

= $5500/MT·(.25) = **$1,375/MT**

TOTAL = $15.9 M

4) FLOOR SPACE:

THE SEA 1995 STRUCTURAL MATERIALS INVENTORY DATA BASE INCLUDES APPROXIMATE SQUARE FOOT AREA ESTIMATES FOR ALL ROCKY FLATS SITE FACILITIES (TOTAL > 3 M ft^2). THIS DATA BASE WAS QUERIED FOR CONCRETE FACILITIES HAVING SOME AMOUNT OF CONTAMINATION, WHICH GENERATED APPROXIMATELY 1,770,000 ft^2.

5) BELOW GRADE VOID SPACE

ASSUMPTIONS

1) 30% TOTAL FLOOR SPACE LOCATED BELOW GRADE

2) WALLS ARE 8 ft.

$$1{,}770{,}000\ ft^2 \cdot 8\ ft \cdot {}^{1\ yd}/_{27\ ft^3}$$

$$= 524{,}444\ yd^3$$

$$\div 1.308\ {}^{yd^3}/_{cm} = 400{,}951\ cm$$

$$@\ 30\% = 121{,}000\ CM$$

6.) Demolition Costs.

Assumptions:

1) 1,770,000 ft² Buildings
2) 30% Below Grade
3.) Costs = \$20/ft² Above Grade
\$40/ft² Below Grade

$\Rightarrow$ .3 (1,770,000) · \$40 = \$21.2 M Below Grade
.7 (1,770,000) · \$20 = \$24.8 M Above Grade

Total Above & Below Grade Demo Costs = **\$46M**

6a.) Transportation

1) Assume a) 750 Miles to NTS = 1500 miles Round Tri[p]
b) 40 Miles to Erie = 80 miles Round Tri[p]
c) 20 Miles from Backfill = 40 Miles Round Tri[p]
2) Project Duration of 7 years
3) 200 Working Days per Year

$\Rightarrow$ Truck Crossings/Day = $\frac{\text{Total Trips}}{7y \cdot 200\ \text{days}/y} \cdot 2$ (in and out)

$\Rightarrow$ Total Miles = Trips · Round Trip Miles

7.) Disposal Costs

Assumptions:

1) All Low Level Wast @ NTS

Low Level

a) Transportation = $2,500 trip

b) Tipping = $8.50/ft³

2) 40,000 lb/trip max load

3) 1 MT conc. debris = .873 Cubic Meter Packaged Waste

Transportation

40,000 #/trip · 1 MT/2200 lb = 18.18 MT/trip

⇒ 18.18 MT/trip · .873 CM/1 MT = 15.8 CM/trip

$2500/trip ÷ 15.8 CM/trip = $160/CM

Tipping.

$8.50/ft³ · 27 ft³/yd³ · 1.308 yd³/cm = $300/cm

Total = $460/cm

Sanitary

Assumptions:

1) All sanitary to Erie

a) Transportation = $350/trip

b) Tipping = $16/ton

2) 40,000 lb/trip max load

Tipping = $16/ton · ton/2000 lb 2200 lb/MT = $17.6/MT

Transportation = 40,000 lb/trip / 2200 lb/MT = 18.2 MT/trip

$350 trip / 18.2 MT/trip = $19.2/MT

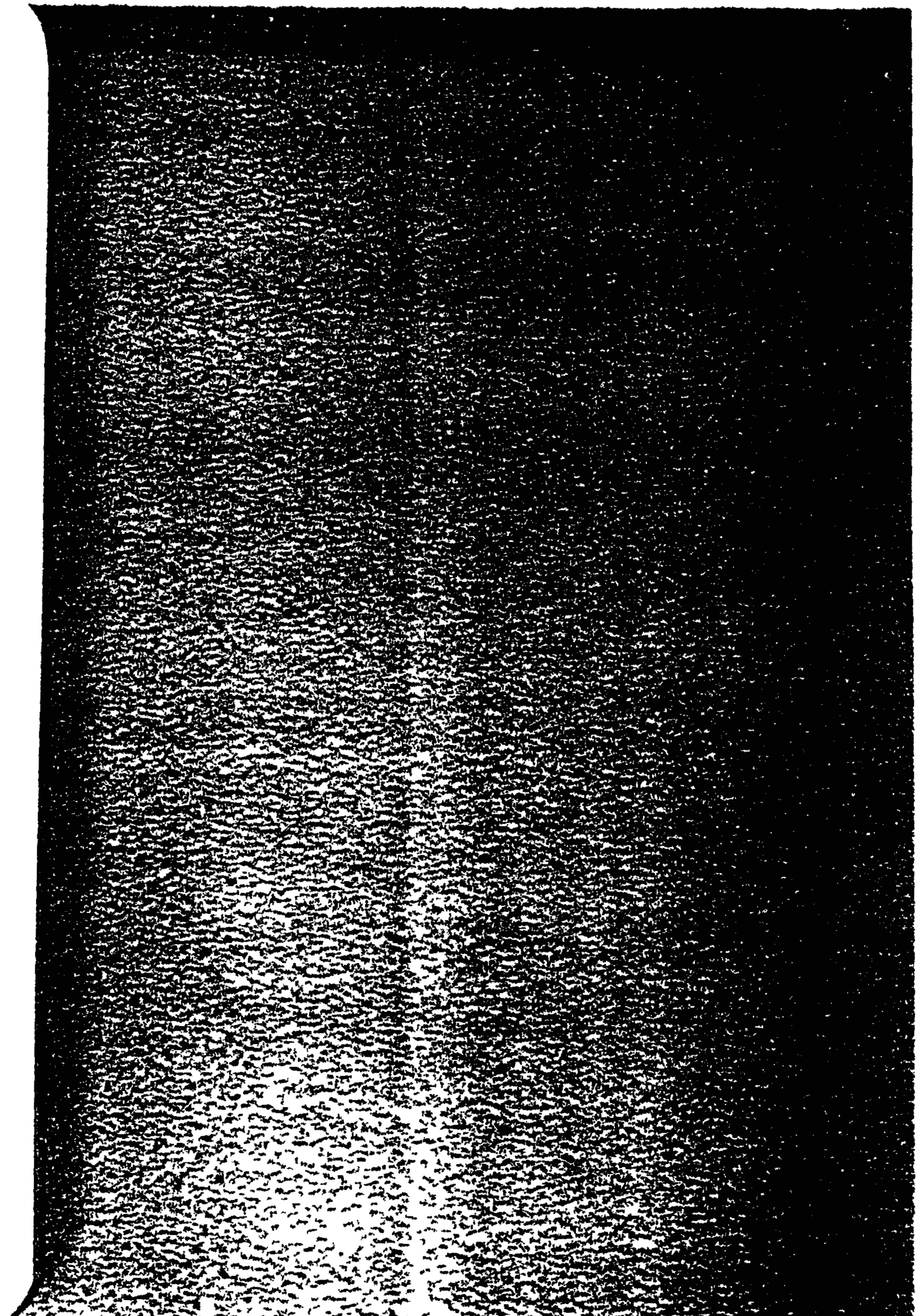
Total = $37/MT

Pocket
Reference
Book

Cedarapids

A **Raytheon** Company

FOURTEENTH EDITION



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Weights of Various Materials

Material	Average Per Cu Ft, Lbs	Average Per Cu Yd, Lbs
ASHES	40	1080
BASALT		
Broken	122	3300
Solid	188	5076
BRICK		
Common Red	120	3240
Fire Clay	150	4050
Silica	128	3456
Chrome	175	4725
Magnesia as brick or fused in furnace	160	4320
CALICHE	90	2430
CEMENT		
Portland	100	2700
CINDERS	30	810
CLAY		
Dry Lumps	67	1822
Wet Lumps	100	2700
FINE GROUND CLAYS SILICA, CEMENT ETC		
Fire Clay	85	2295
Silica Cement	75	2025
Magnesia Cement	127	3429
Chrome Cement	135	3645
Grain Magnelsite (as shipped)	112	3024
COAL AND COKE		
Anthracite	54	1458
Bituminous	49	1323
Charcoal	13	351
Coke	26 3	710
CONCRETE		
Cinder	110	2970
✱ Stone or Gravel	145	3915
EARTH		
Loam, Dry, Loose	76	2052
Loam, Packed	95	2565
Loam Soft, Loose, Mud	108	2916
Loam, Dense, Mud	125	3375
GRANITE Crushed	103	2778
GRAVEL		
Loose	100	2700
✱ Gravel and Sand	111	3000
GRAVEL, SAND AND CLAY, STABILIZED		
Loose	100	2700
Compacted	150	4050
GYPSUM Crushed	100	2700
HEMATITE, Broken	210	5430
LIME		
Quick Loose Lumps	53	1431
Quick Fine	75	2025
Stone, Large Rocks	168	4536
Stone, Irregular Lumps	96	2592
LIMESTONE, Crushed	97	2625
LIMONITE Broken	154	4159
MAGNETITE, Broken	205	5528

Material	Average Per Cu Ft, Lbs	Average Per Cu Yd, Lbs
MASONRY		
Granite or Limestone	165	4455
Mortar, Rubble	154	4158
Dry	138	3726
Sandstone, Dressed	144	3888
METALS		
Aluminum	165	4455
Brass, Cast	534	14418
Bronze	509	13743
Copper, Cast	556	15012
Iron, Cast	450	12150
Iron, Wrought	485	13095
Lead, Cast	708	19116
Lead, Rolled	711	19197
Steel, Cast	490	13230
Steel, Rolled	495	13365
Tin, Cast	459	12393
Zinc, Cast	440	11880
MUD		
Fluid	108	2916
Packed	110	3200
PHOSPHATE ROCK, Broken	110	2970
ROCK		
Chalk	137	3699
Granite	175	5725
Gypsum	159	4298
Sandstone	147	3969
Pumice Stone	40	1080
Quartz	165	4455
Salt, Coarse	45	1215
Salt, Fine	49	1323
Shales	162	4374
Slate, American	175	4725
SAND		
Dry and Loose	100	2700
Dry and Packed	110	2970
Wet and Packed	130	3510
Gravel Packed	118	3186
SHALE, Broken	90	2430
SLAG, Broken	110	2970
STONE, Crushed	100	2700
TRAP ROCK, Broken	109	2950

Concrete Disposition Options

Basis / Assumptions

- **229,000 Metric Tons OR 100,000 Cubic Meters**
  (Gross Weight) **(Solid Volume)**
- **70% Above Grade --- 30% Below Grade**
- **Total of 33,000 Metric Tons Low Level Waste**
  - 11,550 Metric Tons LLW Removed as Solid Mass
  - 21,450 Metric Tons LLW Removed by Surface Decon
- **Demolition Cost Below Grade = 2x Above Grade**

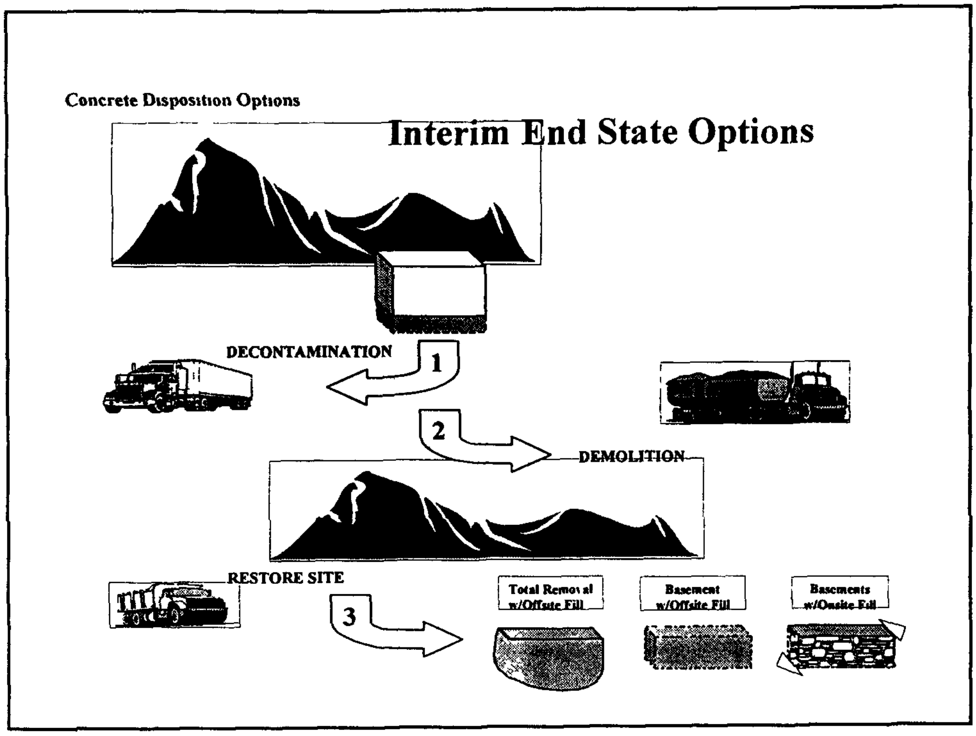
o Metric Tons to Cubic Meters 2,200 lbs / Metric Ton
1 308 yds / Cubic Meter
3,900 lbs / Cubic Yard

o Bulking Factors Solid to Rubble = 1 3 (Increased Void Space)
LL Packaging = 0 875 Metric Ton = 1 Cubic Meter

Package Volume

o Disposal Costs NTS = $550 / Cubic Meter
($300 tipping + $250 transportation)

Erie = $37 / Metric Ton
($17 6 tipping + $19 2 transportation)

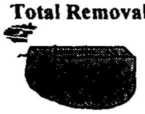


- Issue = Must leave a site that allows the Industrial Use Scenario
- First Option = Remove a structural concrete and backfill w/ Off Site Material
- Second Option = Leave 'decon'd' basements and backfill w/ Off Site Material
- Third Option = Leave 'decon'd' basements and backfill w/ Decon'd On Site Material

Concrete Disposition Options

Technical Approaches

Total Removal



- All Low Level Waste
- 1" Decontamination
- Smart Characterization & Decontamination

Basements w/Off Site Fill

- 1" Decontamination
- Smart Characterization & Decontamination

Basements w/ On Site Fill

- 1" Decontamination
- Smart Characterization & Decontamination
- Crush and Separate Concrete Rubble

o Each End State Options has a number of Technical Approaches (up to 50+ Combinations)

o Presenting bounding approaches (all LL --- Crush and Separate) and a number of feasible approaches within the bounding range

o Technical Approaches can be used within one or more End State Options in most cases

o Purpose is to provide knowledge on HOW we technically can accomplish Interim End States

o Focus is to create meaningful discussion on WHAT the Interim End State will be

Evaluation Criteria

- **Safety** (Environmental and Worker Safety)
- **Budget Impact**
- **Stakeholder Acceptance** (Interim End State Compliance)
- **Schedule Performance**
- **Technical Feasibility**

Concrete Disposition Options

Relative Comparison

FACTOR	TOTAL REMOVAL ALL MATERIAL DISPOSED OFF SITE DEMOLITION VOIDS FILLED WITH OFF-SITE FILL MATERIAL			BASEMENTS W/ OFF SITE FILL ABOVE GRADE RUBBLE REMOVED BASEMENTS REMAIN & FILLED WITH OFF-SITE FILL MATERIAL		BASEMENTS W/ ON SITE FILL ABOVE GRADE RUBBLE DISPOSED IN BASEMENTS AND REMAINING VOIDS		
	All Low Level	1st Decon Off Site Disposal	Smart C&D Off Site Disposal	1 Decon Basements Remain	Smart C&D Basements Remain	1 Decon Rubble in Basements	Smart C&D Rubble in Basements	Concrete Crushing & Separations
Worker Safety	H	L	M	L	M	L	M	H
Transportation (Total Trips) (Total Miles) [~Passes/Day]	xL (23 174) (19 400 000) [33]	L (23 114) (4 000 000) [33]	M (23 110) (2,900 000) [33]	M (17 567) (3 600 000) [25]	M (17 220) (2,500 000) [25]	H (4 684) (2,600 000) [7]	H (3 495) (1 500 000) [5]	H (4 997) (2,900 000) [7]
Budget Acceptance	L $185 2M	L $201 3M	H $117 7M	M $173 7M	H $92M	M $157 2M	H $81 6M	M $151 6M
Stakeholder Acceptance	H	H	H	M	M	L	L	M
Schedule Performance	H	L	M	L	H	M	H	H
Technical Feasibility	M	H	M	H	M	H	M	L

High (H) = Most desirable in range

Low (L) = Least desirable in range

- Relative Comparison High = Best among Range --- Low = Worst among Range

- Safety = All Options and Approaches can be 'reasonably' accomplished,
  BUT! there is a wide range (worker hours / # of trucks) between options
  (Discuss #'s)

- Cost = Roughly $100M to $200M = **<u>Concrete costs Only!!!</u>**

- Technologies range from 'Do Nothing' (all Low Level) to ' New Approaches' (crush and separate)

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Concrete Disposition Options

Next Steps

- Continue Discussions and Analysis
- Identify Preferred Option and Approach
- Decision required by ______

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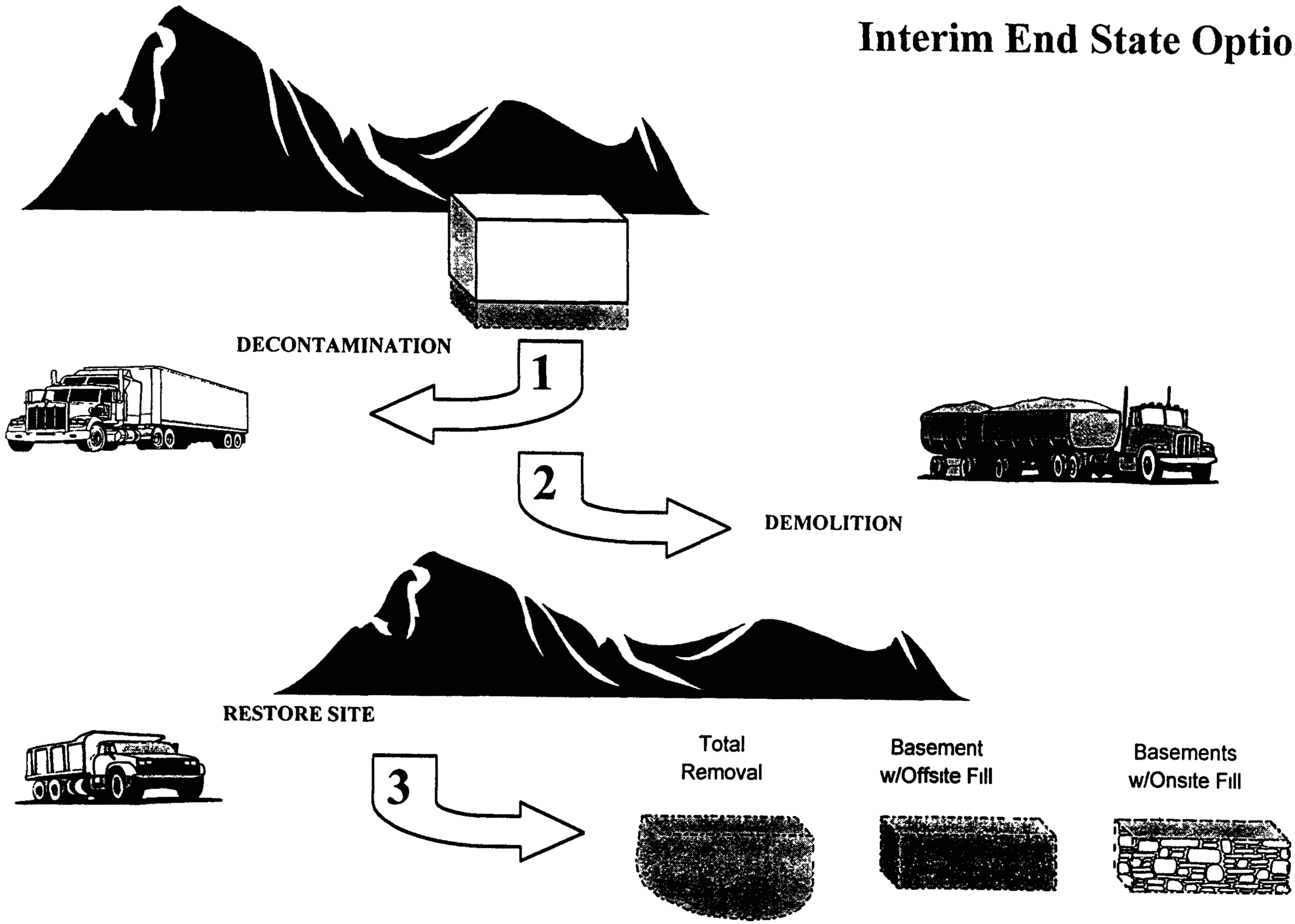
Concrete Disposition Options

Interim End State Options

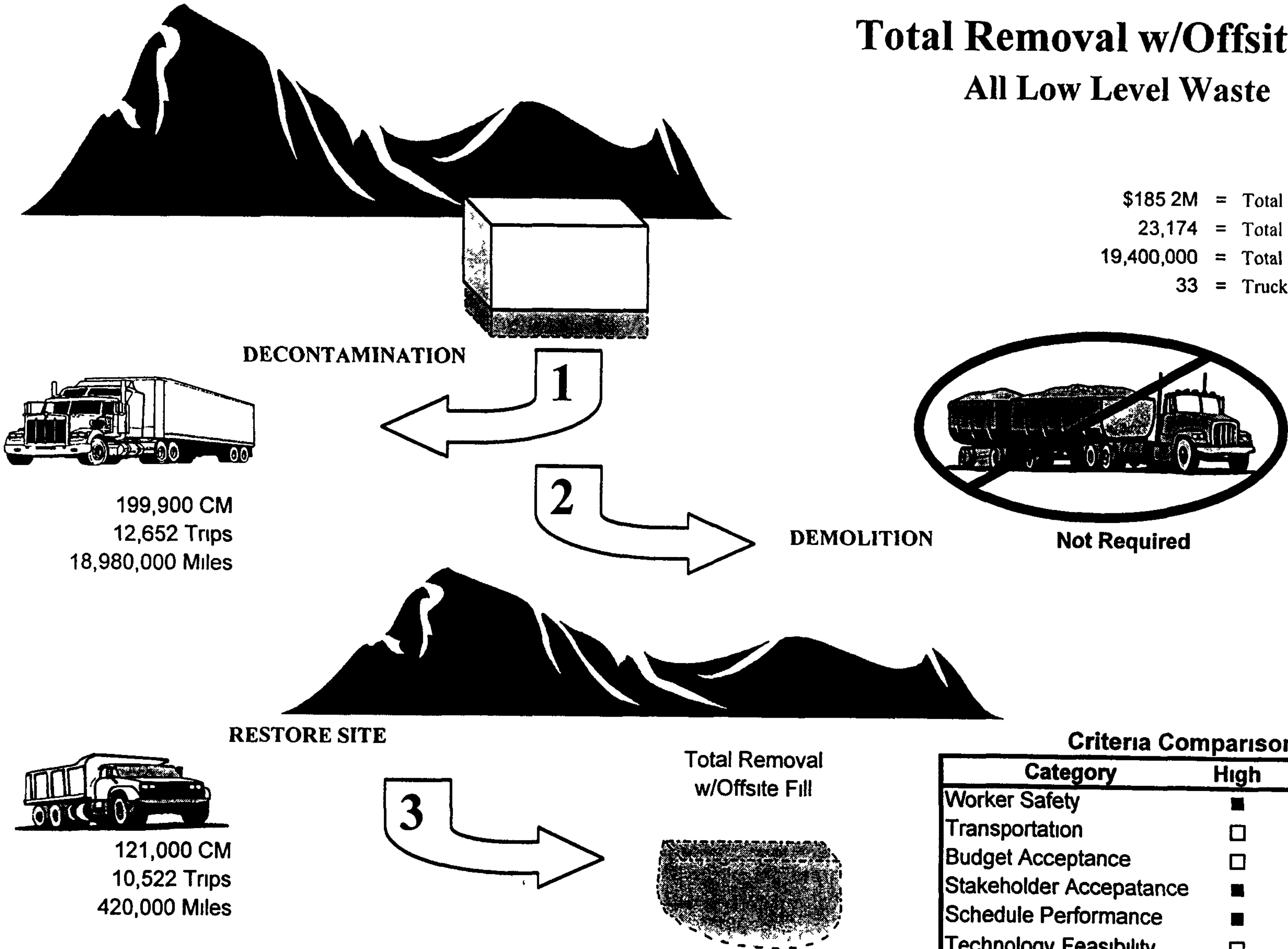


Concrete Disposition Options

Total Removal w/Offsite Fill

All Low Level Waste

$185 2M = Total Cost
23,174 = Total Trips
19,400,000 = Total Miles
33 = Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	■	□	□
Transportation	□	□	■
Budget Acceptance	□	□	■
Stakeholder Accepatance	■	□	□
Schedule Performance	■	□	□
Technology Feasibility	□	■	□

All Low Level - 7/28/97

Description
Demolish and remove entire structure, assume entire structure is Low Level waste

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

No decontamination

Dispose of
199,900 CM Low Level Waste
at NTS
cost $92M

Transportation

12,652 trips Low Level
18,980,000 miles
0 trips sanitary

10,522 trips backfill
420,000 miles

23,174 Total trips
19,400,000 miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = $92

No sanitary waste, assume all material is low level

Fill voids to grade with suitable fill material 121,000 CM
cost = $1 2M

Estimated costs

Low level waste $0 (generate) + $92M (disposal) = $92M
Sanitary waste $92M (demo) + $0 (disposal) + $1 2M (backfill) = $93 2M
Total = **$185 2M**

Assumptions/Issues for discussion
Key
1 Reduced characterization and elimination of release survey costs not considered
2 Demolition costs doubled over baseline to account for low level waste
Standard
1 35% low level contaminated concrete removed in bulk form (i e saw cut) prior to scabbling
2 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
3 30% of floor space associated with basements (8 ft wall), yielding 121,000 CM void
4 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
5 Backfill for building voids purchased from vendor @ $10/CM
6 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
7 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 4 · ALL DISPOSED AS LOW LEVEL
· BACKFILL VOIDS

ASSUMPTIONS:
1) DEMOLITION COSTS DOUBLE

L.L. GENERATION = 2($46M) = $92M

DISPOSAL = 229,000 MT (.873 CM/MT) = 199,900 CM
@ $460 /cm = $92M

TRUCKS = 199,900 cm / 158 cm/TRIP = 12,652 TRIPS

BACKFILL = 121,000 CM = $1.2M
10,522 TRIPS

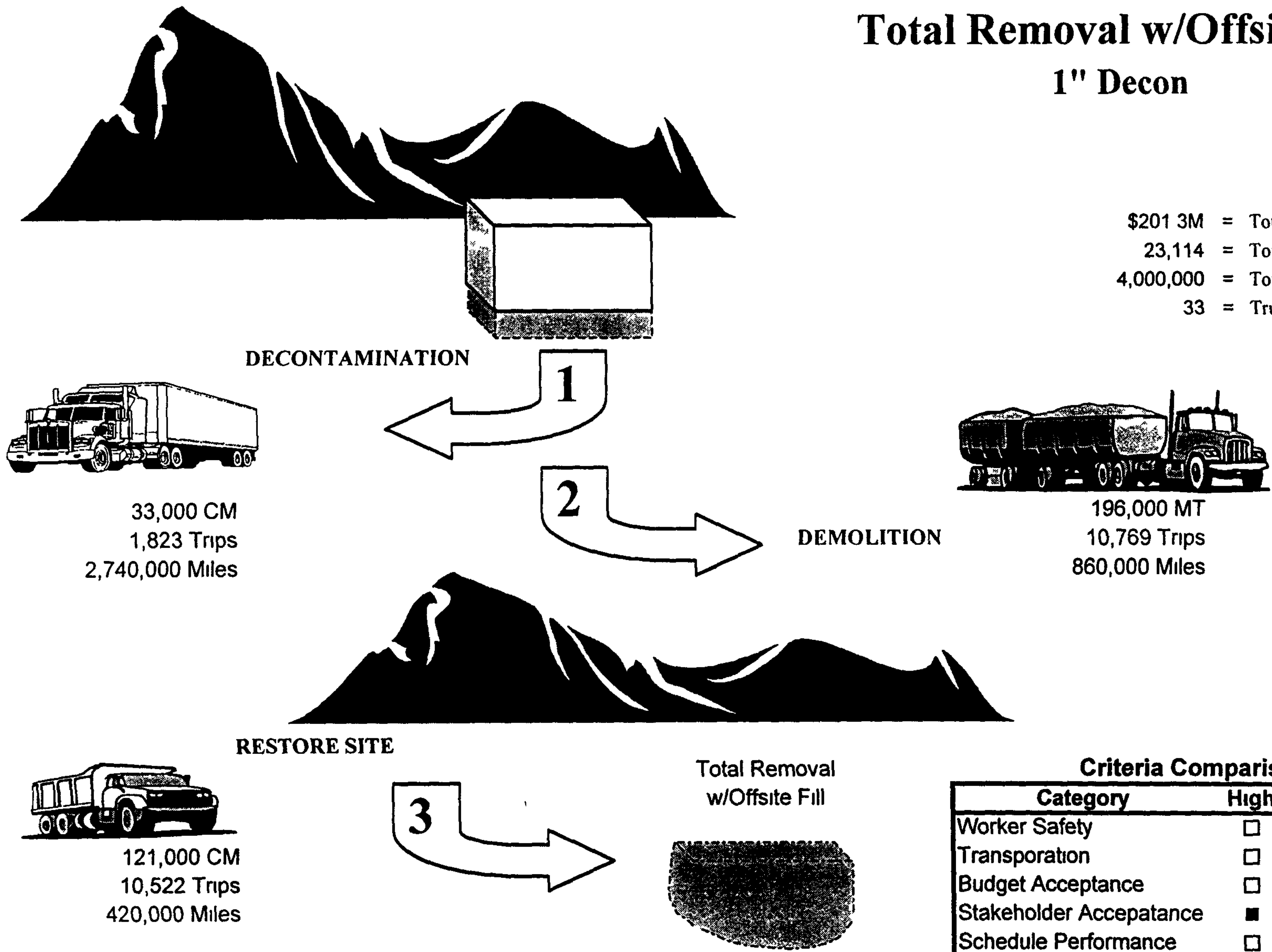
TOTAL = $185.2M   TRIPS = 23,174

Concrete Disposition Options

Total Removal w/Offsite Fill

1" Decon

$201 3M	=	Total Cost
23,114	=	Total Trips
4,000,000	=	Total Miles
33	=	Truck Crossings/Day



Criteria Comparison

Category	High	Med	Low
Worker Safety	☐	☐	■
Transporation	☐	☐	■
Budget Acceptance	☐	☐	■
Stakeholder Accepatance	■	☐	☐
Schedule Performance	☐	☐	■
Technology Feasibility	■	☐	☐

1" Decon - Total Removal (off-site) 7/28/97

Description

Demolish and remove entire structure, Low level waste to NTS, Demolition debris to off-site landfill (Erie)

Structural Concrete on Site
196,000 MT Sanitary
33,000 MT Low Level

Low Level Waste

Remove bulk contamination
11,550 MT - **$15 9M**
Decon Concrete entire structure to off-site free release 21,450 MT - **$117 6M**

Dispose of 28,809 CM Low Level Waste at NTS
cost $13 3M

Transportation

1,823 trips Low Level
2,740,000 miles
10,769 trips sanitary
860,000 miles

10,522 trips backfill
420,000 miles

23,114 Total trips
4,000,000 miles

Sanitary Waste

Demolish and remove entire structure (above and below grade)
cost = $46M

Dispose of 196,000 MT demolition debris at off-site sanitary landfill (Erie)
cost $7 3M

Fill voids to grade with suitable fill material 121,000 CM
cost = $1 2M

Estimated costs

Low level waste $15 9 (bulk) + $117 6M (scabble) + $13 3M (disposal) = **$146 8M**
Sanitary waste $46M (demo) + $7 3M (disposal) + $1 2M (backfill) = **$54 5M**
Total = **$201 3M**

Assumptions/Issues for discussion·

1 Removing 1" of all interior surfaces gains free release of remaining structure
2 30% of structure is located below grade
3 Total area to decon is 3 92M s ft (2 74M above grade, 1 18M below grade) @ $30/s ft
4 Release limit and criteria have been established for free release of concrete to public landfill
5 1,770,000 s ft of structure to be demolished ($20/s ft above grade, $40/s ft above grade)
6 30% of floor space associated with basements (8 ft wall), yields 121,000 CM void
7 NTS disposal costs = $460/CM ($300 disposal, $160 transportation)
8 Sanitary waste disposal costs = $84/CM ($40 disposal, $44 transportation)
9 Backfill for building voids purchased from vendor @ $10/CM
10 Transportation volumes LL 15 8 CM/trip, Sanitary 18 2 MT/trip, Backfill 11 5 CM/trip
11 Transportation distance (miles -round trip) NTS 1,500, Erie 80, Backfill source 20

OPTION 1 · REMOVE SOLID CONTAMINATION
· DECON 1" INTERIOR SURFACES
· ALL DISPOSED OFF-SITE

GIVEN: 196,000 MT SANITARY
33,000 MT L.L.

L.L. GENERATION:

SCABBLE: 3.92 M ft² ($30/ft²) = $117.6 M

SOLID MASS: 11,550 MT ($1375/MT) = $15.9 M

L.L. DISPOSAL

33,000 MT · .873 CM/MT = 28,800 CM L.L. (PACKAGED

28,800 CM · $460/CM = $13.3 M

TRUCKS = 28,800 CM / 15.8 CM/TRIP = 1823 TRIPS

SANITARY GENERATION: = $21.2 M BEL. + $24.8 M ABOVE = $46 M

SANITARY DISPOSAL = 196,000 MT · ($37/MT) = $7.3 M

TRUCKS = 196,000 MT / 18.2 MT/TRIP = 10,769 TRIPS

BACKFILL = 121,000 CM @ $10/CM = $1.2 M

TRUCKS = 121,000 CM / 11.5 CM/TRIP = 10,522 TRIPS

TOTAL = $201.3 M TRIPS = 23,114