Department of the Army
Baltimore District, Corps of Engineers
Washington Aqueduct Division

Draft NPDES Permit Review Memorandum on Residual Solids Evaluations

AH Environmental Consultants, Inc.
and
GREELEY AND HANSEN LLC

January 2003
Issued May 22, 2003
Revised May 30, 2003

Department of the Army
Baltimore District, Corps of Engineers
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1.0 Background and Purpose

The Washington Aqueduct Division traces its origins back to 1798, when George Washington expressed the belief that Potomac River water brought from above Great Falls would provide an ample water supply for the Federal City.

The Washington Aqueduct Division (Aqueduct) is the wholesale water supplier for the District of Columbia (District), Arlington County, Virginia (Arlington County), the City of Falls Church, Virginia (Falls Church) and several federal agencies. In turn, Falls Church distributes Aqueduct water to approximately 120,000 residents of Fairfax County, Virginia. The Aqueduct is a federal agency owned, operated and maintained by the U.S. Army Corps of Engineers (Corps) as a division of the Baltimore District of the Corps. The Aqueduct's customers pay the costs for capital improvements, operations and maintenance.

The Aqueduct has raw water intakes on the Potomac River at Great Falls and Little Falls. Treatment is provided at two plants, Dalecarlia and McMillan. A diagram of the Aqueduct's basic facilities is shown on Figure 1. Solids removed from the Georgetown Reservoir and the Dalecarlia Sedimentation Basins are returned to the Potomac River. Solids that accumulate in the Dalecarlia Reservoir Forebay are periodically dredged and land applied.

There has been continued interest and discussions for a number of years over the practice of returning residual solids from the treatment process to the Potomac River. The United States Environmental Protection Agency (EPA) issued a revised draft permit for the Aqueduct on December 18, 2002. The draft permit includes principal limits for discharges to the Potomac River as follows:

	Discharge Limitations	
Effluent Characteristic	Avg. Monthly	Max. Daily
Total Suspended Solids	30 mg/l	60 mg/l
Aluminum (Total)	4 mg/l	8 mg/l

Also, discharges from the Dalecarlia Sedimentation Basins and the Georgetown Reservoir are prohibited during the spring spawning season (February 15 through June 30). Additionally, 85 percent removal of incoming solids to the sedimentation basins is required.

The Aqueduct will have to seek other means for residual solids handling and disposal to meet the proposed permit requirements. This memorandum has been prepared to acquaint the Aqueduct and its customers with potential alternatives for the handling and disposal of residual solids. Alternatives have been developed on a conceptual level and some preliminary cost evaluations prepared to bracket the array of potential alternatives.

2.0 Basic Information

In the early 1990's, the Aqueduct anticipated that discharges of residual solids to the Potomac River would eventually be strictly controlled. Such control was likely to extend to elimination of the discharges. A plan to dewater solids at the Dalecarlia plant was developed. The existing plan provides for the following:

- Periodic dredging of solids from the Dalecarlia Reservoir Forebay
- Continuous withdrawal of solids from the Dalecarlia Sedimentation Basins
- Periodic withdrawal of solids from the Georgetown Reservoir
- Gravity thickening and centrifuge dewatering of the residual solids at the Dalecarlia plant and trucking the dewatered solids off-site to final disposal

A diagram of the existing plan is shown on Figure 2 and estimated quantities and characteristics of the residual solids are summarized in Table 1.

3.0 Potential Alternatives

The Aqueduct evaluated a number of alternatives in arriving at the existing plan. The existing plan for solids handling and disposal would eliminate discharges to the Potomac River but concerns of other impacts from such an operation have been raised. The concerns over the existing plan are principally focused on the neighborhood impacts from truck traffic, but questions regarding better use of existing Aqueduct assets and use of regional assets have also been stated.

In view of the concerns and questions surrounding the existing plan, an array of other options has been developed to afford the Aqueduct and its customers a preliminary review of other possibilities. Two basic categories of alternatives have been developed as follows:

- A group of general alternatives structured around use of Aqueduct facilities, and
- A second group of other alternatives structured around use of regional facilities.

The general group of residuals alternatives is diagrammed on Figure 3. The alternatives shown on Figure 3 have features as follows:

- A modified existing plan has been developed. In addition to the facilities included in the existing plan, this plan provides for treatment of liquids from the dewatering operation rather than recycle those liquids to the Dalecarlia Reservoir. The treated liquid would be discharged to the Potomac River to meet permit limits.

- Alternatives No. 1, 2, 3 and 4 are options to dewatering at Dalecarlia. They include combinations of dredging, transfer to McMillan, transfer to Blue Plains, dewatering at McMillan and some transfer to Arlington and Falls Church.

- Alternatives No. 5, 6, 7 and 8 are structured around use of the Dalecarlia Reservoir as the principal solids removal facility. Under these alternatives, coagulation chemicals would be applied in the reservoir and any solids removed in the Dalecarlia Sedimentation Basins and Georgetown Reservoir would be recycled to the Reservoir. Solids produced in the Reservoir would be removed by dredging or transferred to McMillan for dredging or dewatering. Some dewatering at Dalecarlia would also be provided.

The other alternatives group is diagrammed on Figure 4 and includes transferring residuals from the Aqueduct to existing regional dewatering facilities or to regional quarries.

4.0 Evaluation of Alternatives

The alternatives arrayed on Figures 3 and 4 were screened and several selected to be developed further to identify the capacities and character of facilities. The alternatives selected for further development are shown as follows:

Alternative No.	Shown on Figure
Modified Existing Plan	5
1	6
2	7
3	8
4	9
5	10
8	11

Additionally, variations to Alternatives No. 4 and 8 were developed. These variations are shown on Figure 12 and are based on some discharge to the Potomac River as may continue to be allowed under the proposed permit. The discharge to the river includes the Dalecarlia Forebay solids and 15 percent of production.

Several of the alternatives listed above and the existing plan were selected for economic comparisons. The modified existing plan together with Alternatives No. 4, 5, 8, 4A and 8A were selected for economic comparison with the existing plan. These alternatives were selected to bracket potential alternatives to the existing plan and provide a preliminary assessment of economic as well as operational differences. Preliminary cost opinions were prepared based on updating costs from previous Aqueduct studies and experience. The preliminary opinions of costs have been summarized in Tables as follows:

Table	Description
2	Summary of Capital Costs, which includes construction costs plus other project costs
3	Summary of Annual Costs, which is the sum of Operations and Maintenance Costs plus the annual debt service on Capital Cost

Opinions of costs and other features for the existing and modified plans together with those for Alternatives No. 4, 5, 8, 4A and 8A have been summarized for comparison as follows:

Item	Exist. Plan Dewater @ Dalecarlia	Mod. Ex. Plan Exist & Liq. Tr'mt	Alt. No. 4 Transfer to McMil Dewater & Dredge	Alt. No. 5 Treat in Dale Res Period. Dredge	Alt. No. 8 Treat in Dale Res Dewater & Dredge	Alt. No. 4A No. 4 with Part to River	Alt. No. 8A No. 8 with Part to River
A. ESTIMATED COSTS - $1M							
1. Capital	$63.4	$73.4	$49.6	$13.9	$45.9	$43.8	$39.9
2. Annual	11.4	12.5	12.1	13.0	10.3	10.1	8.9
3. % Above Low Annual	28.1	40.4	36.0	46.1	15.7	13.5	0
4. % Above Low Annual (without 4A and 8A)	10.7	21.4	17.5	26.2	0	-	-
5. % Above Low Annual (without No. 8)	0	9.6	6.1	14.0	-	-	-
B. PROJECT FEATURES							
1. Discharge to Potomac	No	Minor	No	No	No	Yes	Yes
2. Treatment Process	Existing	Existing	Existing	New	New	Existing	New
3. Truck Traffic							
a. At Dalecarlia	Yes	Yes	No	Yes	Yes	No	Yes
b. Daily Trips Days per Wk	10 5	10 5	4 5	-	4 5	3 5	3 5
c. Dredging							
▪ Frequency	-	-	Every 7 Yrs for 2 Yrs	Every 3 Yrs for 2 Yrs	Every 5-6 Yrs for 2 Yrs	-	-
▪ Daily Trips Days/Yr			19 365	15 365	15 365		

Findings based on the foregoing comparison of costs and project features are as follows:

- Alternatives No. 4A and 8A are lowest in annual cost and the difference in annual cost between these two alternatives is not economically significant. However, both alternatives are based on some continued discharge to the river that may not be acceptable under the proposed permit.

- If continued discharge to the river (to the degree included in Alternatives No. 4A and 8A) proves to be acceptable, Alternative 4A would appear to be attractive compared to Alternative 8A because 4A is based on employing the existing treatment process at Dalecarlia while 8A requires a change in that process. Under Alternative 4A, all solids handling and disposal would be transferred to McMillan. This would increase truck traffic in the McMillan neighborhood and this situation would require evaluation to determine the feasibility for such an operation.

- If continued discharge to the river proves to be unacceptable, Alternative No. 8 appears to be the lowest annual cost project. Compared to the existing plan, the economic difference between the two is not significant. Under Alternative No. 8, the daily truck traffic would be less than half of that predicted for the existing plan. But during dredging operations, the truck traffic would increase substantially and persist for about 2 years. Also, under Alternative No. 8 new treatment process routines would have to be implemented. These latter features may make Alternative No. 8 unattractive compared to the existing plan.

- If continued discharge to the river and employing new treatment process routines prove to be unacceptable for non-economic reasons, the existing or modified existing plans and Alternative No. 4 are not economically different. The selection of the existing plan or modified existing plan over Alternative No. 4 would appear to hinge on project features such as truck traffic and location of handling facilities for the residual solids. If the truck traffic issue at Dalecarlia were mitigated, the existing plan or modified existing plan would appear to be preferable to Alternative No. 4.

5.0 Plan Selection

The evaluations conducted have not examined all of the potential alternatives. Some findings depend on the conditions in the final NPDES permit. Additionally, some options will require the Aqueduct to adopt new management and process routines.

It does appear, however, that adopting multiple technologies (e.g. transfer from Dalecarlia, dredging and continued river discharge) may offer cost effective and operational advantages.

Before selecting a final plan, additional studies should be made. These studies should consider (as a minimum) the following:

- Conditions in the final NPDES Permit
- Feasibility of some continued discharge to the river
- Feasibility of some discharge to Blue Plains
- Dewatering at a remote industrial type site
- Contract operations at some site
- Multiple sites for residuals handling
- Some joint operations with regional facilities

The studies should incorporate factors related to economics, the environment, technical operations and long-term reliability.

TABLE 1

Department of the Army
Baltimore District, Corps of Engineers
Washington Aqueduct Division

Summary of Residual Solids Quantities

Greeley and Hansen LLC
January 2003
Issued May 22, 2003

Item	Estimated Residual Solids Production and Rates [1]				
	Filters Backwash	**Dalecarlia Forebay**	**Dalecarlia Sed. Basins**	**Georgetown Reservoir**	**Totals [2]**
1. Dry Solids Production – Dry lbs/day (Enhanced Coagulation)					
Annual Average	500	20,200	28,000	23,400	51,400
Maximum Month	1,100	50,000	68,800	65,700	
Maximum Week	1,200	113,800	95,900	95,900	
2. Removal Schedule					
Days per Year	As needed	90	365	90	
Hours per Day	As needed	7	20	7	
3. Removal Rate (An. Avg.)					
Lbs/day (dry)	NA	81,900	28,000	94,900	
Percent Solids	NA	1.0	0.25	1.0	
Gals/day	NA	982,000	1,343,000	1,138,000	
Pumping Rate – Hrs/day	NA	20	20	20	
– mgd	4.53	1.18	1.61	1.37	
4. Combined Removal (An. Avg.)					
Period – months			Jan - Dec	Jun - Oct	
Pumping Rate – mgd					
• Jun thru mid Oct			1.61	1.37	2.98
• Mid Oct thru May			1.61	-	1.61
Removal – 1,000,000 lbs/yr (dry)			10.22	8.54	18.76

(1) Source: Design Memorandum, Whitman Requardt and Associates, Nov 1996
(2) Dalecarlia Sed. Basins plus Georgetown Reservoir

TABLE 2

Department of the Army
Baltimore District, Corps of Engineers
Washington Aqueduct Division

Preliminary Opinion of Capital Costs
Selected Alternatives

Greeley and Hansen LLC
January 2003
Issued May 22, 2003

Item	Estimated Capital Cost ($1,000s)						
	Existing Plan	Modified Existing Plan	Alternative No. 4	Alternative No. 5	Alternative No. 8	Alternative No. 4A	Alternative No. 8A
Dalecarlia Sed. Basins, PS, Renovations	12,413	12,413	12,413	3,103[(6)]	3,103[(6)]	12,413	3,103[(6)]
Georgetown Reservoir PS and Renovations	7,195	7,195	7,195	4,317[(7)]	4,317[(7)]	7,195	4,317[(7)]
Dalecarlia Forebay PS and Renovations	2,508	2,508	0	0	2,508	0	2,508
Dalecarlia Waste Stream Handling Facilities	2,667	2,667	2,667	2,667	2,667	2,667	2,667
Dalecarlia Solids Dewatering Facilities	35,094[(1)]	35,094[(1)]	0	0	23,396[(8)]	0	19,757[(12)]
Dalecarlia Wastewater Treatment	0	9,482[(2)]	0	0	4,300[(9)]	0	2,200[(13)]
Dalecarlia/Georgetown Residuals Pipeline	0	0	10,646[(3)]	0	0	7,297[(10)]	0
McMillan Reservoir Improvements	0	0	2,205[(4)]	0	0	2,205[(4)]	0
McMillan Solids Dewatering Facilities	0	0	11,698[(5)]	0	0	9,592[(11)]	0
Dalecarlia Reservoir Chemical Facilities	0	0	0	3,088	3,088	0	3,088
Other Support Facilities @5.9%	3,510	4,092	2,763	777	2,560	2,441	2,221
Total – Capital Cost	63,387	73,451	49,587	13,952	45,939	43,810	39,861
Annual Amortized Capital Cost (7%, 20 yrs.)	5,983	6,933	4,681	1,317	4,336	4,135	3,762

(1) 6 centrifuge units at 45,000 dry lbs/day each
(2) 3 plate settler units at 8.9 mgd each
(3) 20” 34,000 LF pipeline
(4) Reservoir improvements for solids storage
(5) 2 centrifuge units at 45,000 dry lbs/day each
(6) Without sed. basin solids collection equipment
(7) Reduced capacity solids handling facilities
(8) 4 centrifuge units at 45,000 dry lbs/day each
(9) 2 plate settler units at 5.0 mgd each
(10) 16” 34,000 LF pipeline
(11) 2 centrifuge units at 37,000 dry lbs/day
(12) 4 centrifuge units at 38,000 dry lbs/day each
(13) 2 plate settler units at 3 mgd each

TABLE 3

Department of the Army
Baltimore District, Corps of Engineers
Washington Aqueduct Division

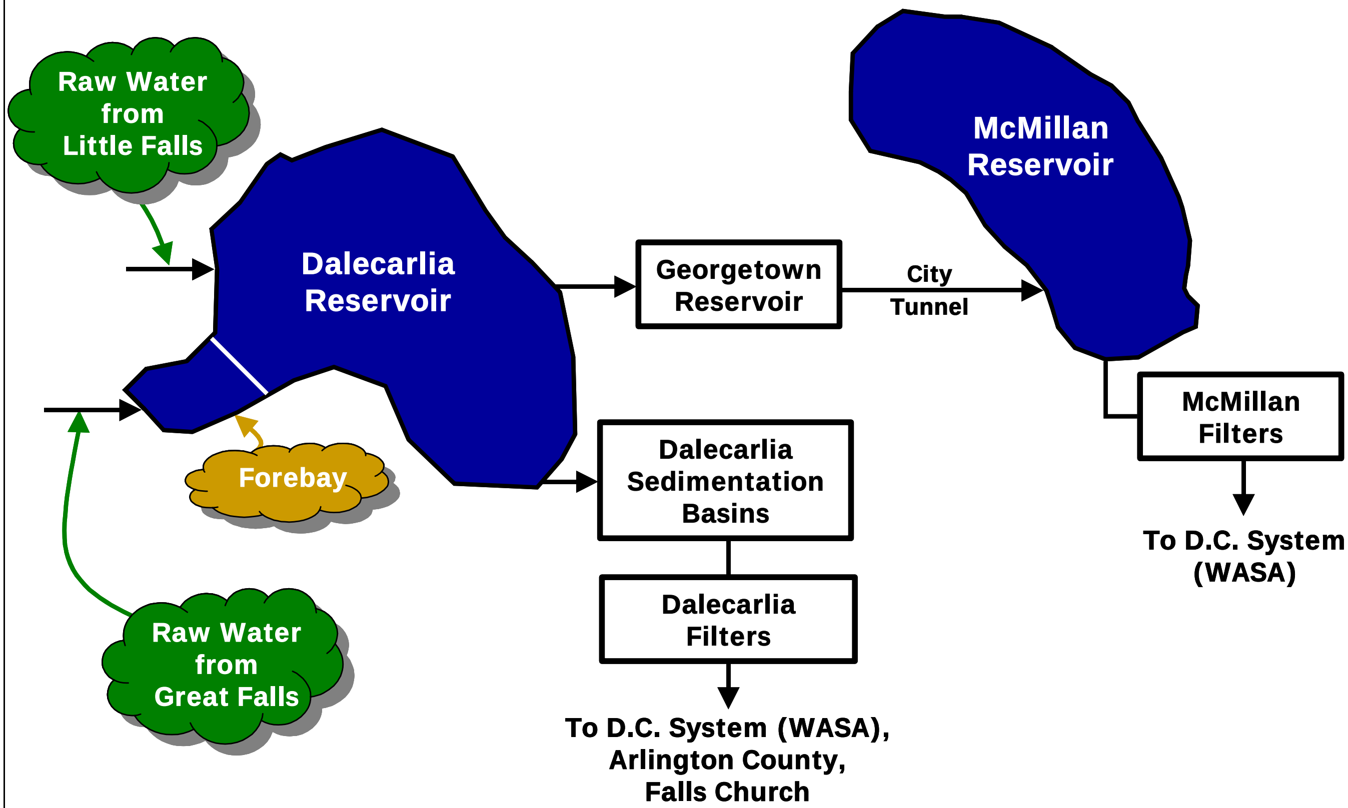
Preliminary Opinion of Annual Costs
Selected Alternatives

Greeley and Hansen LLC
January 2003
Issued May 22, 2003

Item	Estimated Annual Costs ($1,000s) [17]						
	Existing Plan	Modified Existing Plan	Alternative No. 4	Alternative No. 5	Alternative No. 8	Alternative No. 4A	Alternative No. 8A
Annual Amortized Capital Costs (7%, 20 yr)	5,983	6,933	4,681	1,317	4,336	4,135	3,762
Annual Operation and Maintenance Costs							
Electrical Power	404	425	186	50	425	186	425
Chemical	283	297	283	283	297	232	244
Labor	223	335	223	111	335	335	335
Maintenance and Equip. Replacement	61	64	20	20	64	20	64
Land Application	2,767[1]	2,767[1]	2,312[3]	3,577[5]	3,577[5]	1,728[11]	3,025[15]
Land Fill Disposal[18]	1,186[2]	1,186[2]	411[4]	0	0	307[12]	0
Dredging, Dewatering and Disposal	0	0	664[6]	0	0	664[6]	0
Dredging and Dewatering	0	0	2,887[7]	7,627[8]	0	2,159[13]	0
Dredging	484[9]	484[9]	484[9]	0	1,278[10]	361[14]	1,080[16]
Subtotal – Annual O & M	5,408	5,558	7,470	11,668	5,976	5,992	5,173
Total – Annual Cost	11,391	12,491	12,151	12,985	10,312	10,127	8,935

(1) Land application at 75% x 72,200 dry lbs/day, 25% cake, $70/WT
(2) Landfill disposal at 25% x 72,200 dry lbs/day, 25% cake, $90/WT
(3) Land application at 75% x 25,000 dry lbs/day + 26,500 dry lbs/day, 25% cake, $70/WT
(4) Landfill disposal @ 25% x 25,000 dry lbs/day, 25% cake, $90/WT
(5) Land application at 70,000 dry lbs/day, 25% cake, $70/WT
(6) Dal. Reservoir at $12.2 M x 1.36/25 year = $664,000/yr.
(7) McMill. Reservoir dredge at 26,500 dry lbs/day, $597/dry ton
(8) Dal. Reservoir at 70,000 dry lbs/day, $597/dry ton
(9) Georgetown Res. at 26,500 dry lbs/day, $100/dry ton
(10) Dal. Reservoir at 70,000 dry lbs/day, $100/dry ton
(11) Land application at 75%, 25% cake, $70/WT, Dal. Solids & 100% GTR solids
(12) Landfill disposal at 25%, 25% cake, $90/WT, Dal. solids
(13) McMill Reservoir dredge at 19,812 dry lbs/day, $597/dry ton
(14) Georgetown dredge at 19,812 dry lbs/day, $100/dry ton
(15) Land application at 59,204 dry lbs/day, 27% cake, $70/WT
(16) Dal. Reservoir at 59,204 dry lbs/day, $100/dry ton
(17) Based on 1994 Montgomery Watson Data adjusted to 2004 cost levels (148%)

FIGURE 1



BASIC FACILITIES

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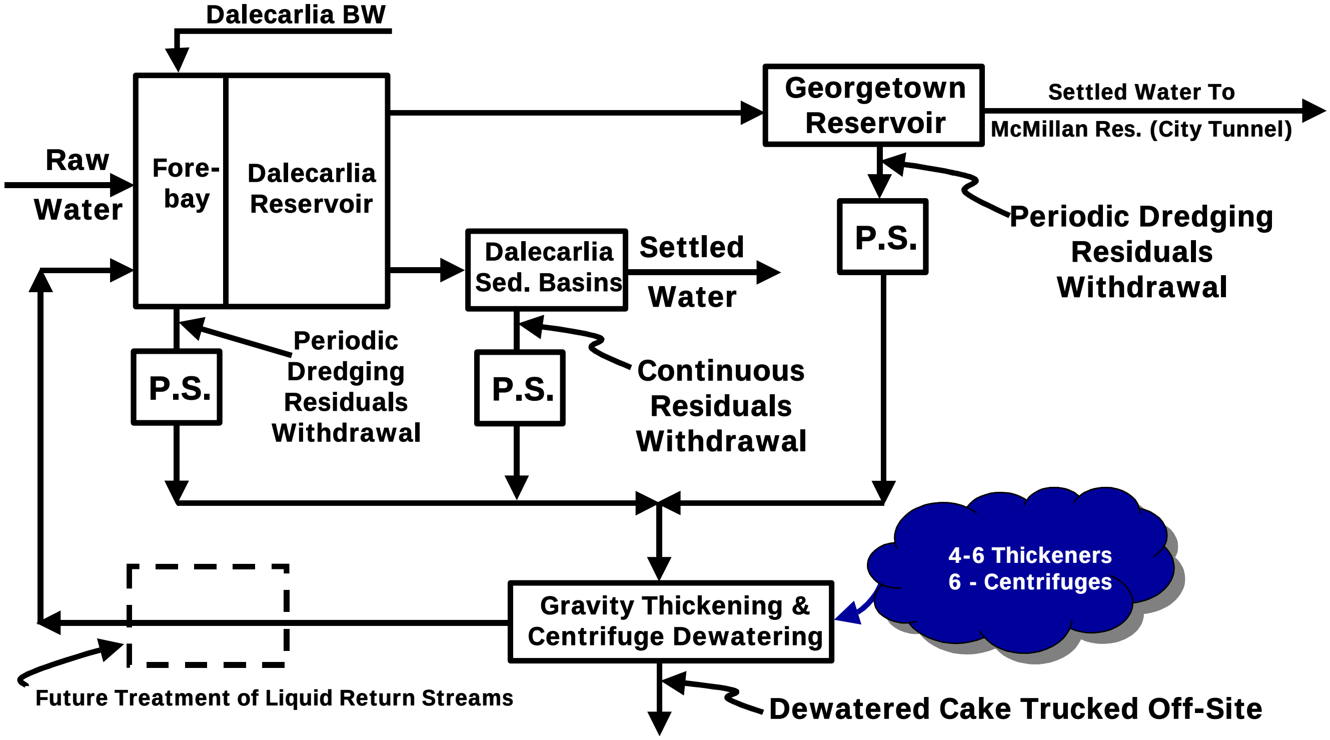
FIGURE 2



BASIC DIAGRAM OF EXISTING PLAN FOR
RESIDUALS HANDLING & DISPOSAL

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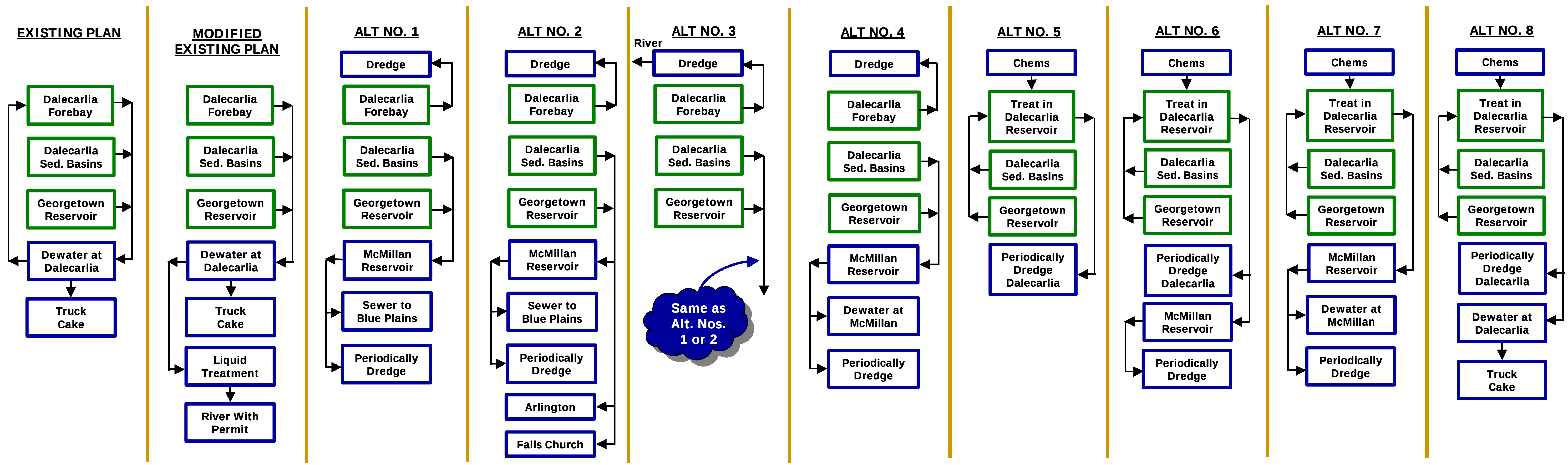
FIGURE 3



GENERAL RESIDUALS ALTERNATIVES

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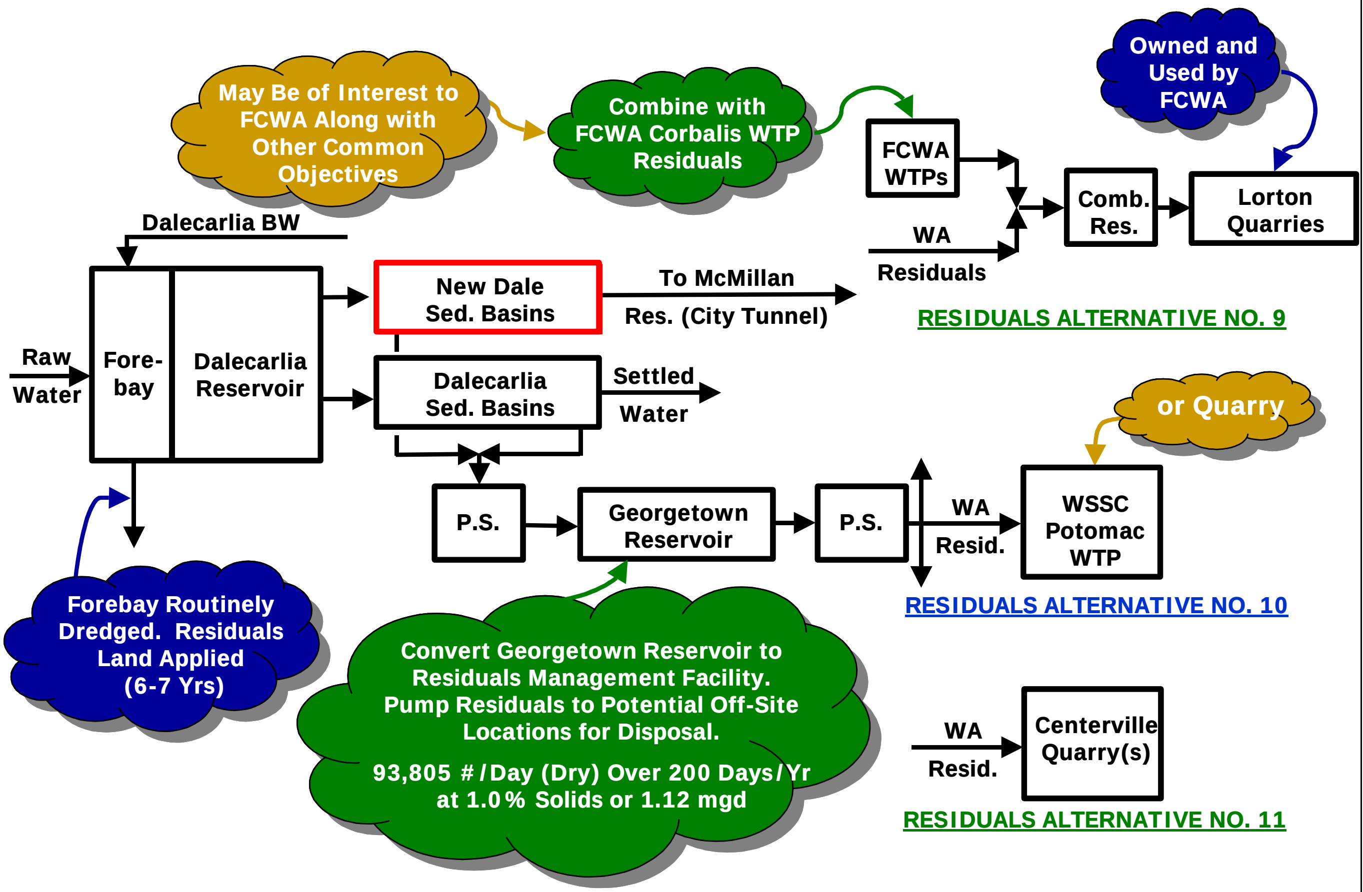
FIGURE 4



OTHER POTENTIAL RESIDUALS ALTERNATIVES

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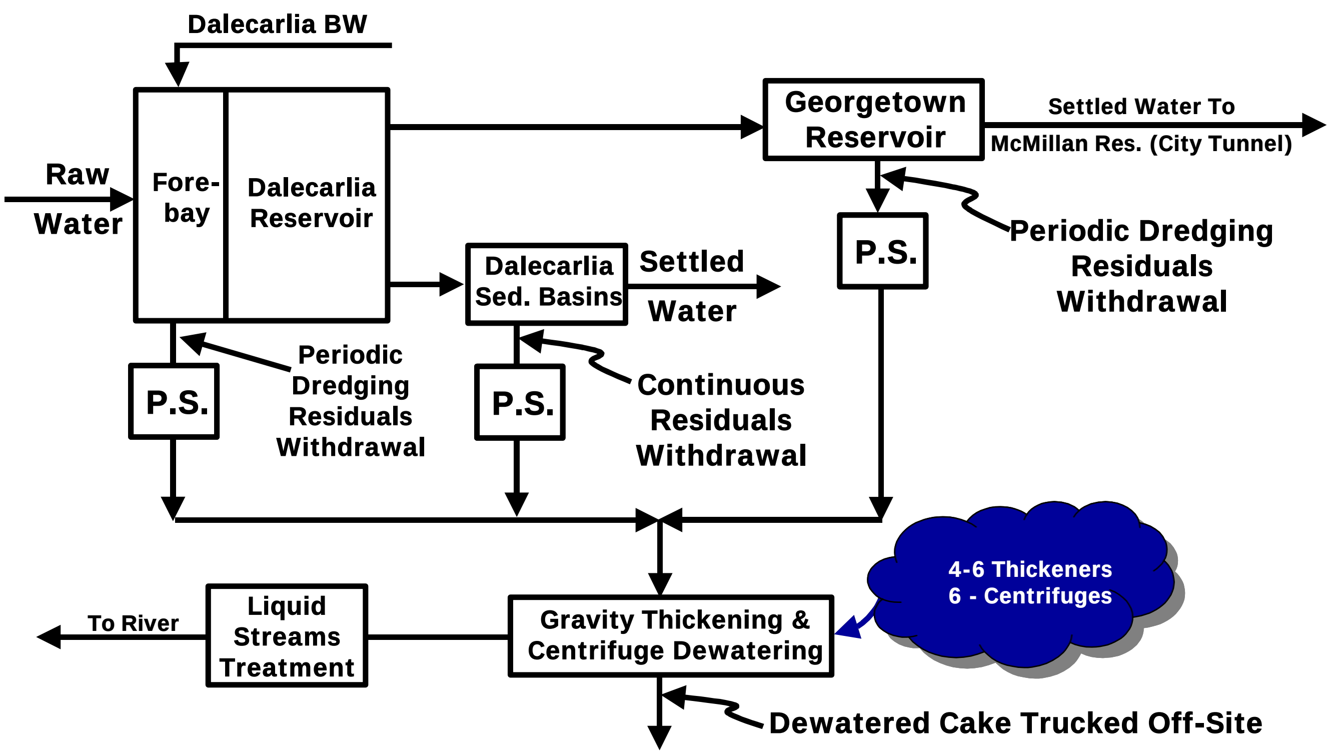
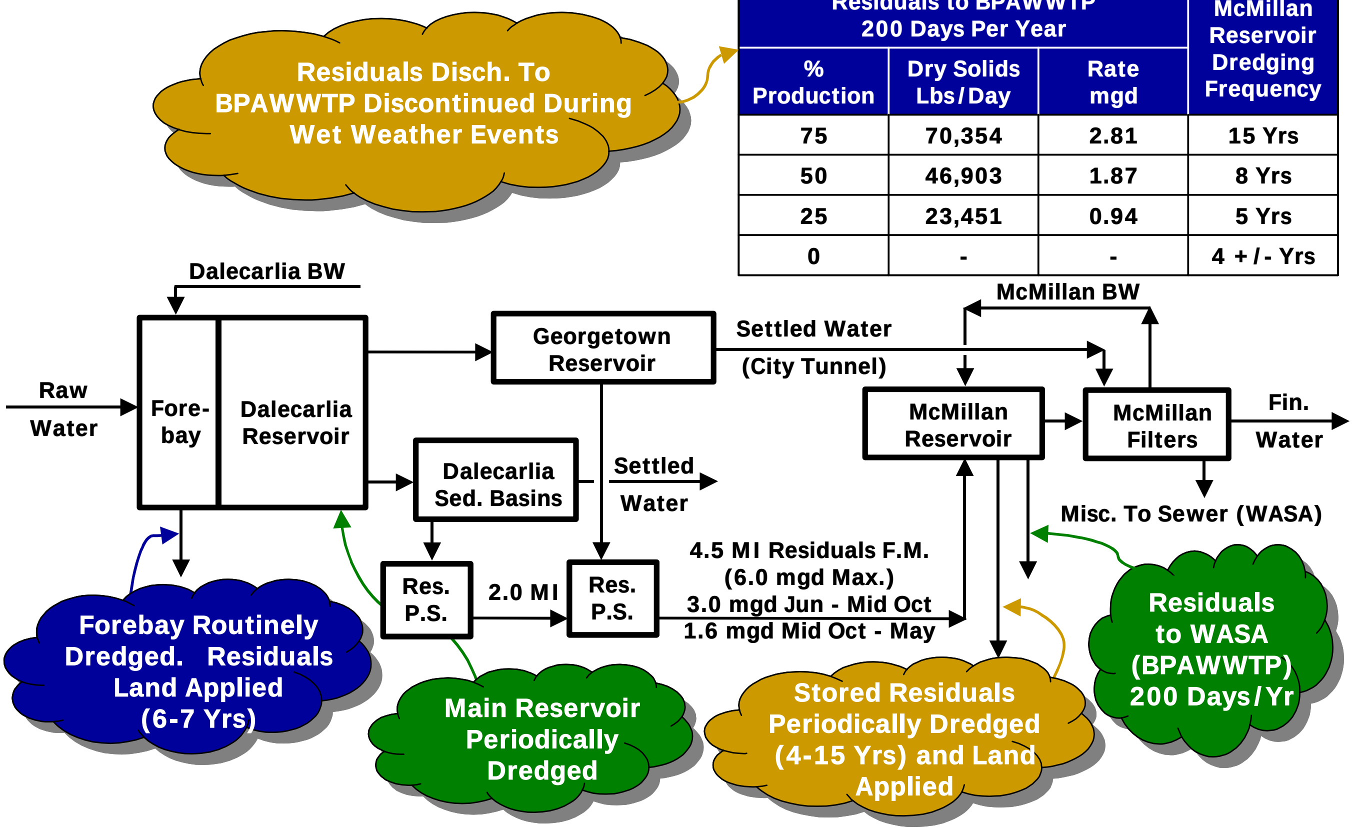


MODIFIED EXISTING PLAN FOR RESIDUALS HANDLING & DISPOSAL

FIGURE 6

Residuals to BPAWWTP 200 Days Per Year			McMillan Reservoir Dredging Frequency
% Production	Dry Solids Lbs/Day	Rate mgd	
75	70,354	2.81	15 Yrs
50	46,903	1.87	8 Yrs
25	23,451	0.94	5 Yrs
0	-	-	4 +/- Yrs



RESIDUALS ALTERNATIVE NO. 1

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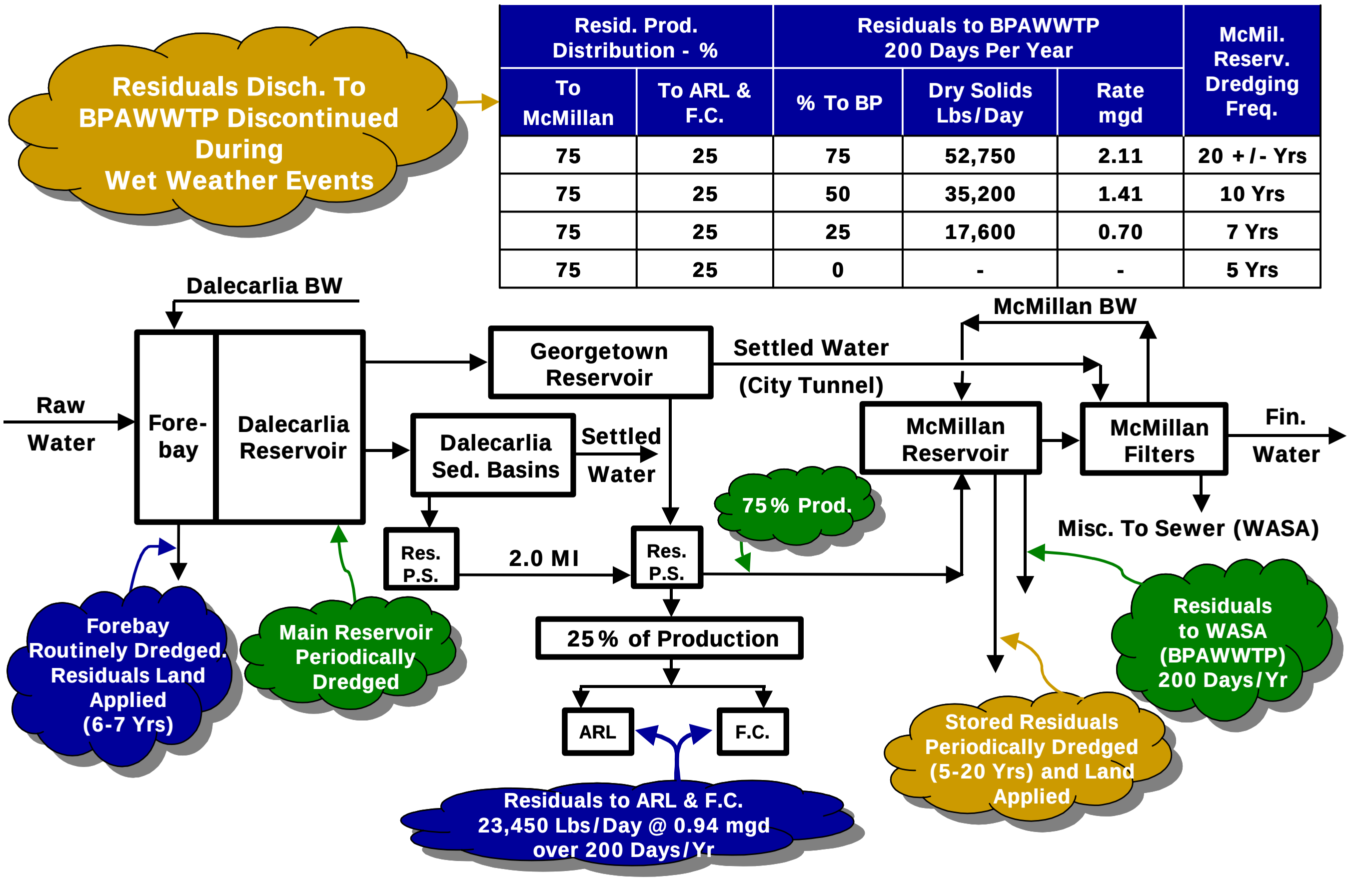
FIGURE 7

Resid. Prod. Distribution - %		Residuals to BPAWWTP 200 Days Per Year			McMil. Reserv. Dredging Freq.
To McMillan	To ARL & F.C.	% To BP	Dry Solids Lbs/Day	Rate mgd	
75	25	75	52,750	2.11	20 +/- Yrs
75	25	50	35,200	1.41	10 Yrs
75	25	25	17,600	0.70	7 Yrs
75	25	0	-	-	5 Yrs



RESIDUALS ALTERNATIVE NO. 2

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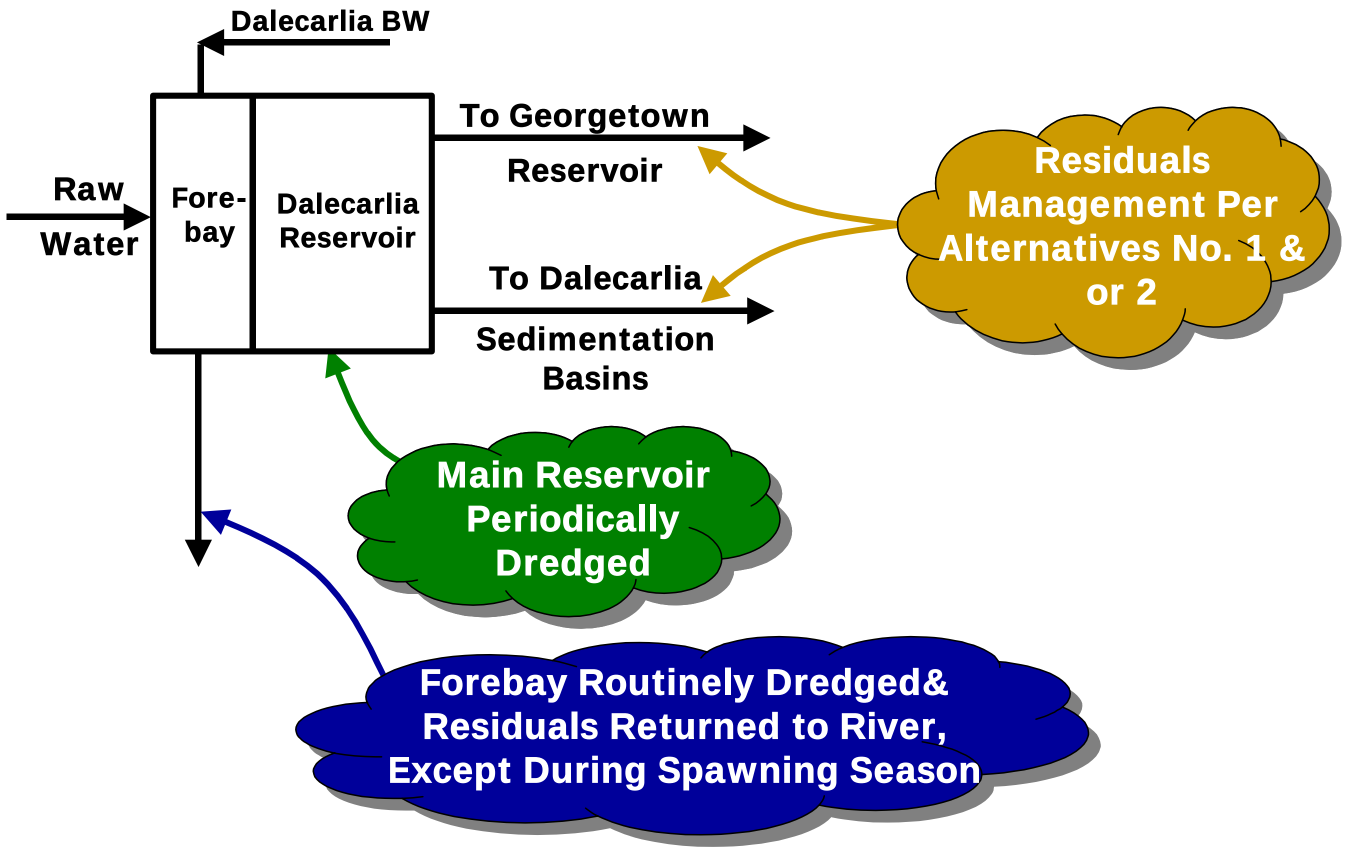
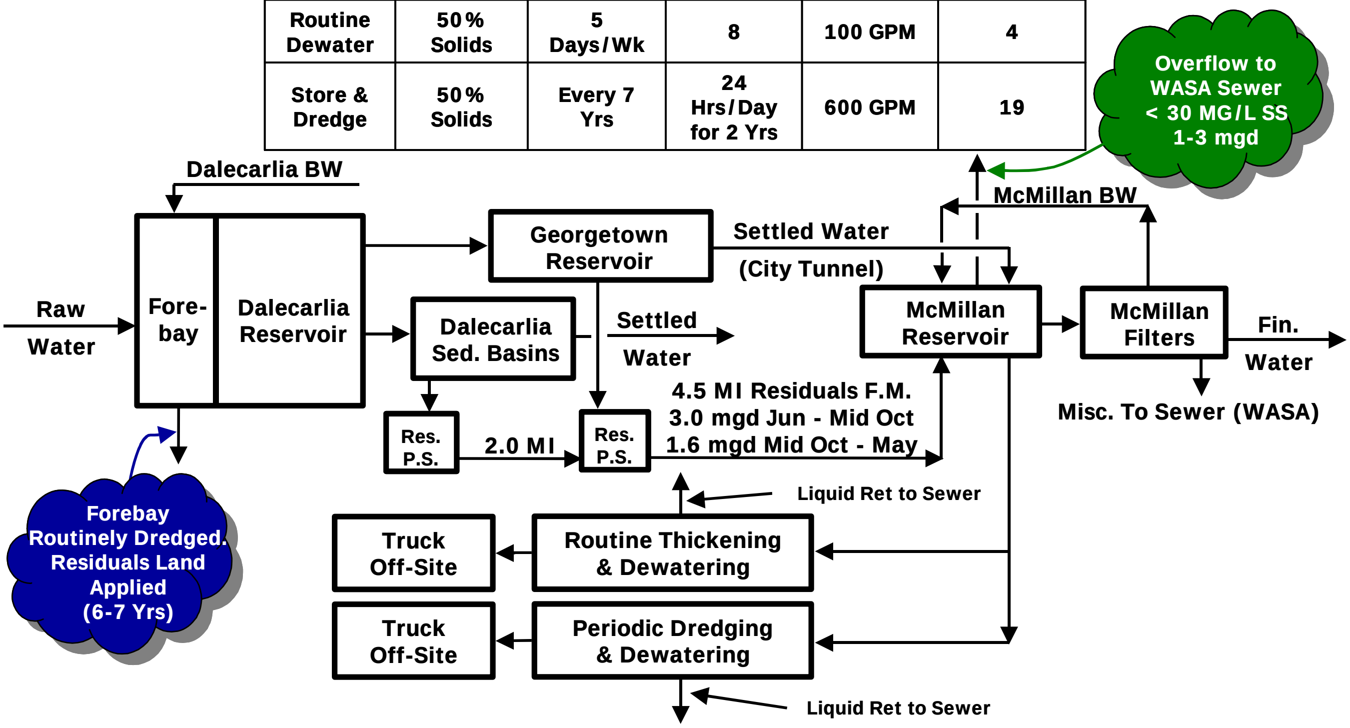


RESIDUALS ALTERNATIVE NO. 3

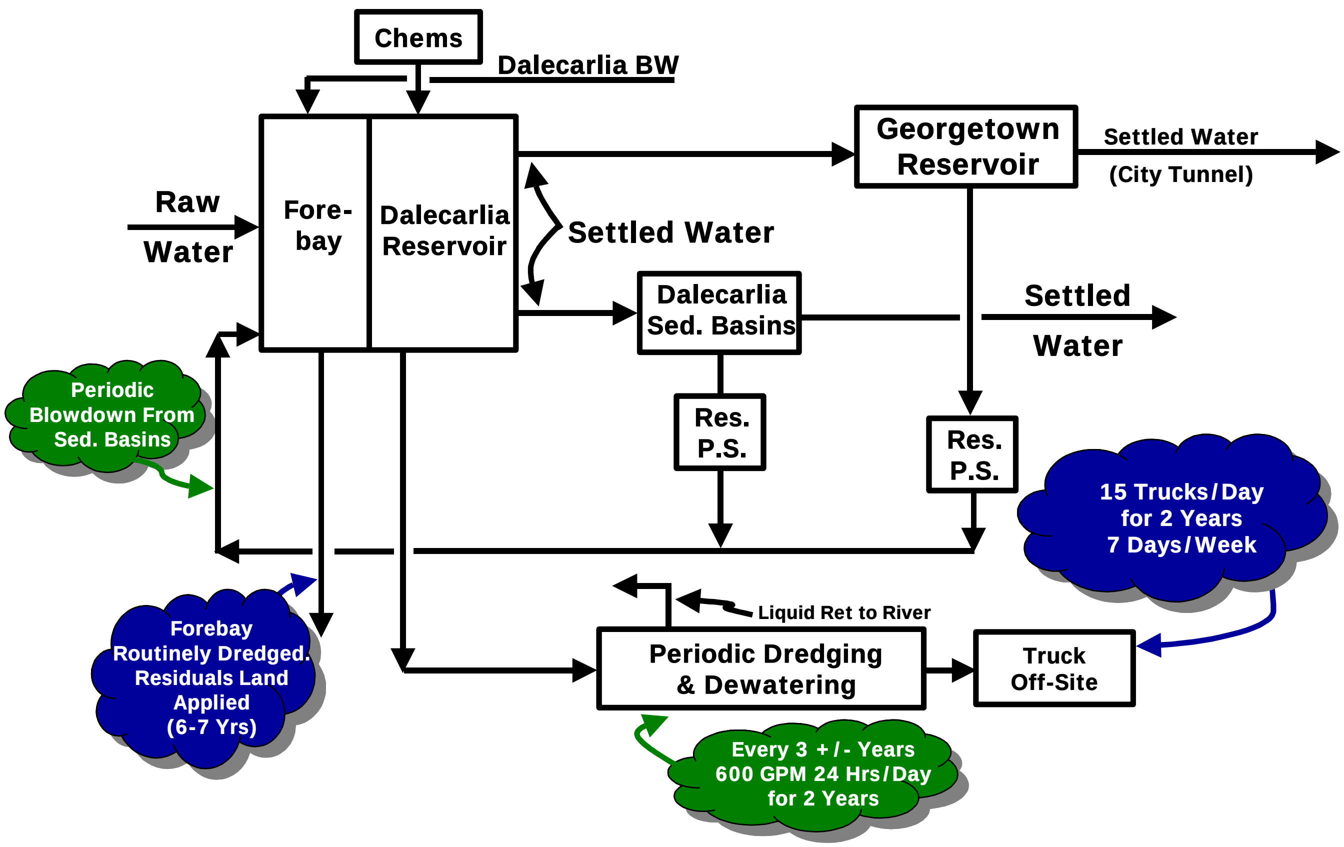
FIGURE 9

McMillan Dewatering Operations					
Operation	Capacity	Frequency	Hrs/Day	Rate	Trucks/Day
Routine Dewater	50% Solids	5 Days/Wk	8	100 GPM	4
Store & Dredge	50% Solids	Every 7 Yrs	24 Hrs/Day for 2 Yrs	600 GPM	19



RESIDUALS ALTERNATIVE NO. 4

FIGURE 10



RESIDUALS ALTERNATIVE NO. 5

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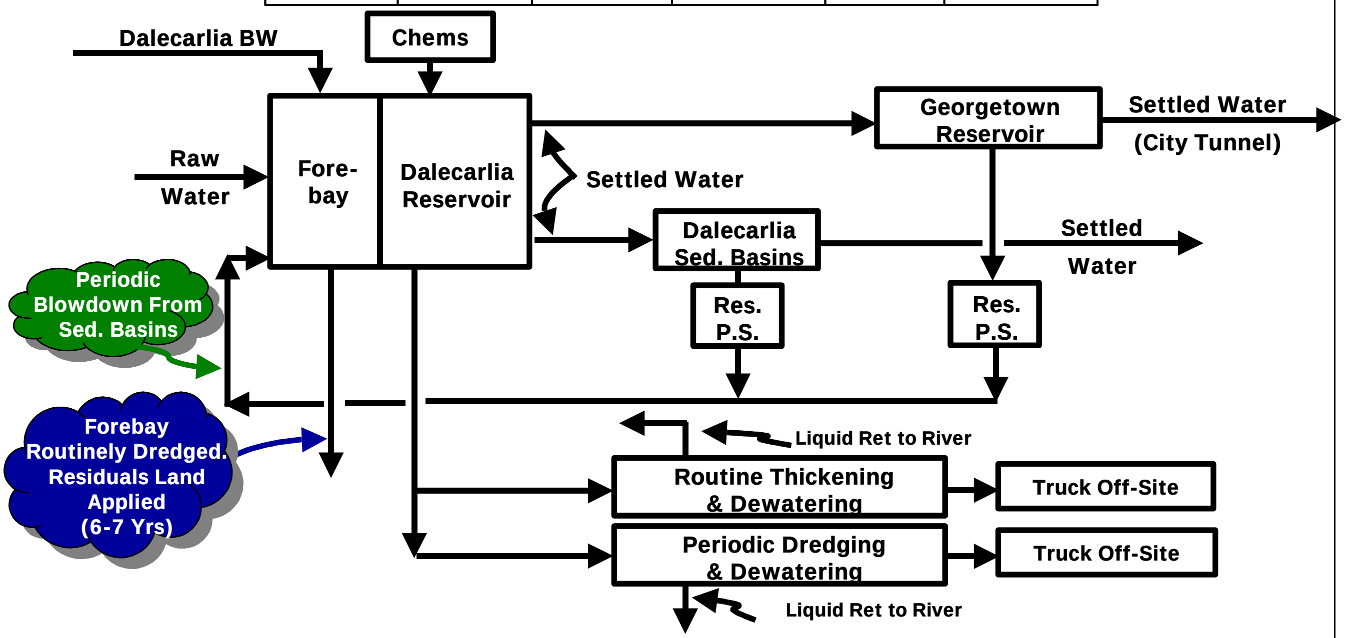
Dalecarlia Dewatering Operations					
Operation	**Capacity**	**Frequency**	**Hrs/Day**	**Rate**	**Trucks/Day**
Routine Dewater	50% Solids	5 Days/Wk	8	100 GPM	4
Store & Dredge	50% Solids	Every 5-6 Yrs	24 Hrs/Day for 2 Yrs	600 GPM	15



RESIDUALS ALTERNATIVE NO. 8

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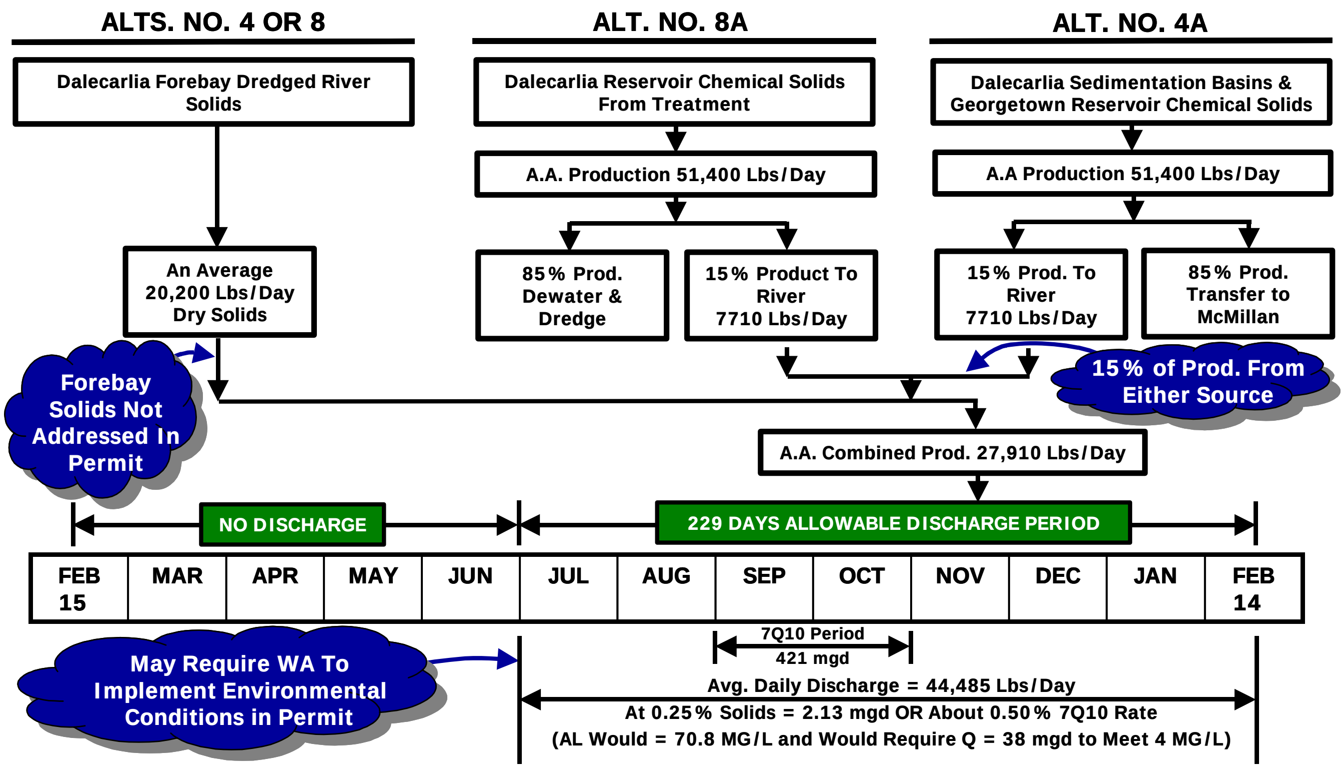
FIGURE 12



RIVER DISCHARGE OPTIONS

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