OUTFALL MAINTENANCE AND DIVERSION PLAN

DEER ISLAND TREATMENT PLANT
BOSTON, MASSACHUSETTS

MWRA CONTRACT NO. 6233
TASK ORDER 15

FOR

MASSACHUSETTS WATER RESOURCES AUTHORITY

METCALF & EDDY, INC.
WAKEFIELD, MA

AUGUST, 2000

DEER ISLAND TREATMENT PLANT
OUTFALL MAINTENANCE AND DIVERSION PLAN

EXECUTIVE SUMMARY

The Deer Island Treatment Plant (DITP) Outfall Maintenance and Diversion Plan contained herein has been developed in accordance with requirements stated in the final DITP NPDES Permit No. MA 0103284. This permit requires the MWRA to maintain the existing harbor outfall system to enable future flow diversion from Outfall TO1, if directed by the Environmental Protection Agency and the Massachusetts Department of Environmental Protection. The Outfall Maintenance and Diversion Plan consists of three distinct sections that provide procedures for flow diversion, maintenance protocols for the existing harbor outfall system, and shutdown and preservation procedures for Outfall TO1. The three sections of this Outfall Maintenance and Diversion Plan are summarized below.

Flow Diversion Plan

The Flow Diversion Plan provides procedures for DITP effluent flow diversion from Outfall TO1 to the existing harbor outfall system. This plan contains advance preparation requirements, guidelines for the number of harbor outfalls necessary for diversion under various tide and flow conditions, impact to plant process and support systems, gate line-up in the diversion flow path, gate opening sequence, and estimated implementation time required to perform these activities.

Two flow diversion procedures are presented. The first procedure is direct diversion, where flow is diverted in its entirety once required preparation activities have been implemented. The second procedure is phased diversion that has been developed to support simultaneous capping of the Outfall TO1 diffuser ports. The phased flow diversion procedure requires that a minimum flow rate be maintained to Outfall TO1 during capping of the diffuser ports to minimize seawater intrusion and potential for biofouling associated with a long-term shut down. Close coordination between diving activities and plant operations is required to implement the phased flow diversion.

The recommended procedure is for direct flow diversion. This procedure reduces complications, avoids flow monitoring and gate throttling required to maintain a minimum flow to Outfall TO1, eliminates coordination between plant operations and diving activities for Outfall TO1, requires a shorter implementation period, and is less costly than the phased flow diversion procedure.

Harbor Outfall System Maintenance Plan

The Harbor Outfall System Maintenance Plan provides maintenance protocols that would allow for future activation of the existing near shore harbor outfall system in accordance with the Outfall Maintenance and Diversion Plan. This plan includes short-term and long-term maintenance protocols for periodic inspecting, equipment exercising, and outfall cleaning as necessary.

The recommended maintenance protocol includes performing a baseline inspection of both onshore and offshore system components shortly after this system is shut down. The results of this inspection will form the benchmark to evaluate future sediment build-up and marine growth. Annual inspections are recommended for onshore and offshore structures and components. Results of the annual inspections will indicate the need for equipment maintenance, sediment and marine growth removal, and additional capital equipment, such as plates or duckbill check valves for the outfall diffusers.

Outfall TO1 Shutdown and Preservation Plan

The Outfall TO1 Shutdown and Preservation Plan prepared by Parsons Brinckerhoff Quade & Douglas, Inc. provides procedures for securing and maintaining the deep ocean outfall during extended idle periods subsequent to flow diversion to the existing harbor outfall system. Short-term and long-term procedures have been developed to protect the outfall during idle periods.

The short-term shutdown procedure would maintain Outfall TO1 in a ready mode with the diffuser ports open. This procedure would allow seawater intrusion and the potential for marine growth inside of the diffusers over time. A dive inspection program would be instituted after an initial 30-day period to monitor the rate of biofouling. The frequency of dive inspections would be adjusted based on the rate of marine growth observed. If the dive inspections reveal significant marine growth blocking an average 10-percent of the diffuser ports, the long-term shutdown protocol would be enacted.

The long-term shutdown procedure would extend well over 30-days and involve capping the diffuser ports. The diffuser port capping procedure could be accomplished either under phased flow diversion or direct flow diversion. Diffuser port capping would prevent seawater exchange and control the rate of marine growth inside the diffusers and tunnel. Marine growth could be further controlled with periodic disinfection of the diffusers through chemical injection ports provided with the port caps. The diving required for capping of the diffusers and chemical injection would be a significant effort and subject to weather and seasonal constraints.

The recommended Outfall TO1 Shutdown and Preservation Plan is the short-term shutdown procedure, followed by the long-term shutdown procedure after direct flow diversion to the harbor outfall system. Due to the complexity and coordination required between diving activities and plant operations, capping the diffuser ports under phased flow diversion is not recommended.

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INTRODUCTION

The Deer Island Treatment Plant (DITP) Outfall Maintenance and Diversion Plan has been developed in conjunction with requirements contained in the final DITP NPDES Permit No. MA 0103284. The specific requirements stated in the permit are as follows:

"Prior to the use of outfall TO1, the MWRA shall submit a plan to EPA, MADEP, and OMSAP for maintaining the physical integrity and capacity of the existing Deer Island outfall system, and explaining how alternative discharge scenarios (including discharge through existing Deer Island outfalls, if necessary) could be implemented. These alternative discharge scenarios must be considered as an option under the MWRA's contingency plan, within the section that outlines a process for developing responses to any future problems. The MWRA shall maintain all facilities in good working order to allow for reestablishment of a discharge through the existing outfalls if deemed necessary."

The plan contained herein, provides the protocol required to implement flow diversion if necessary, maintains the integrity of the existing harbor outfall system, and protects the new outfall if the MWRA is directed to perform a shutdown. The MWRA notes that EPA and DEP considered the potential for flow diversion from Outfall TO1 to the existing harbor outfall system to be remote, as stated in Part I.8.g. of the executive summary to this permit:

"From an environmental perspective, diversion of the discharge back into Boston Harbor would be an option only if the Boston Harbor outfall provided superior water quality benefits or were necessary to remedy other environmental harms, for example to prevent harm to protected species. Because of the benefits provided by the outfall location in Massachusetts Bay in providing dilution, mixing, and distance to shore, the possibility that diversion of the discharge back to the Harbor would be environmentally desirable is remote."

1.1 BACKGROUND

The location for Outfall TO1 was determined based on a comprehensive environmental impact study conducted during the facilities planning phase of the Boston Harbor Project. The statement cited above from the permit is consistent with the following statement made in Volume V Section 1.3 of the March 31, 1988, Secondary Treatment Facilities Plan Final Report:

"The region represents the optimum mix of characteristics of good outfall sites. It is within the large-scale circulation patterns of Massachusetts Bay, and therefore provides the most robust long-term mixing. It is in an area of limited potential sediment accumulation, and thereby avoids problems associated with concentrating pollutants in bottom sediments. It is located away from intensely utilized near-shore resources, and thereby avoids the potential for disruption."

Outfall siting, sizing, and diffuser arrangements for optimizing dilution were developed and modeled to provide a configuration with the least environmental impact on the deep ocean receiving waters of Massachusetts Bay.

In conjunction with the Boston Harbor Project activities, the MWRA has conducted a 7-year, pre-discharge monitoring program in the Massachusetts Bay receiving waters. This program, overseen by an independent panel of marine scientists, is the most comprehensive marine discharge-monitoring program in the United States. Baseline monitoring data will be used to ensure that any impacts from the outfall are consistent with the small impacts anticipated in environmental studies.

1.2 OUTFALL SYSTEM CHARACTERISTICS

Characteristics of new Outfall TO1 and the existing harbor outfall system components are provided in Table 1.1. See Section 3.1 (Existing Conditions) and Section 4.1 (Outfall Description) for additional detail on the respective outfall system characteristics.

TABLE 1.1: DEER ISLAND OUTFALL SYSTEM COMPONENTS

Characteristic	New Outfall					
	TO1	Total	001	002	004	005
Capacity, mgd[a]	1270	400[b]	305[b]	95[b]	closed	closed
Capacity, mgd[a]	1270	700[c]	242[c]	75[c]	383[c]	closed
Capacity, mgd[a]	1270	1100[d]	235[d]	73[d]	376[d]	415[d]
Length, ft	49,626		2565	2260	500	135
Diameter, ft	24.25		10	6.29	9.0	4 x 8[e]
Number of Open Ports	270		47	14	1	1
Port Diameter, ft	0.49-0.64		1.69	1.67	9	9
Port Discharge El, ft	0.00		54.7	54.7	97.8	98
Chamber Invert El., ft	-271.0[f]		98.1	98.1[g]	98.1	103.2
Maximum Operating El.,ft	140.1[f]		120.0[g]	120.0[g]	120.0[g]	120.0[g]
Year Commissioned	1999		1959	1896	1959	1959

Notes:

[a] Existing outfall capacity assumes current operating conditions. Capacity would be affected if the system were modified or if significant sediment build-up or biofouling occurred once the outfall was inactive.

[b] Outfall capacity at mean high tide (El. 110.5) with Outfalls 001 and 002 operating in parallel.

[c] Outfall capacity at mean high tide (El. 110.5) with Outfalls 001, 002 and 004 operating in parallel.

[d] Outfall capacity at mean high tide with all four existing outfalls operating in parallel. Note that flow diversion reduces DITP effluent discharge capacity from 1270 mgd to 1100 mgd at this operating condition.

Outfall system capacity indicated would be reduced as tide levels rise above mean high tide (e.g., storm tides).

[e] Existing 4-ft x 8-ft orifice in Chamber A slide gate was used to determine Outfall 005 hydraulic capacity.

[f] New Outfall TO1 chamber elevations refer to Deer Island outfall shaft.

[g] Existing outfall chamber elevations refer to onshore chambers.

The flows from the MWRA north and south systems were introduced to the DITP in January 1995 and July 1998, respectively. Plant operating data were evaluated to provide an indication of the flow trends from the combined north and south systems over the past several years, and to provide a preliminary indication of average hourly flow frequency over time. Figure 1-1 provides a comparison of the frequency distribution of DITP average hourly influent flow between the periods of January 1995 through December 1996 and June 1998 through June 1999. The 1995-1996 data represent combined flows of the north and south systems with separate treatment at the new Deer Island and old Nut Island Treatment Plants, respectively. The 1998-1999 data represent combined north and south system flows with all treatment occurring at the DITP.

If flow diversion were implemented, then Figure 1-1 could be used to estimate the frequency of use of the various outfalls in the harbor outfall system. Historically, Outfalls 001 and 002 have been operated to capacity prior to activation of Outfall 004. This same protocol would be followed if flow is diverted back to the harbor outfall system.

The capacity of the existing outfalls is provided in Figures 1-2, 1-3, and 1-4. The capacities of the individual outfalls and the total outfall system capacity vary depending on the number of outfalls open and the tide elevation present. The tide elevations indicated on each figure are expressed as Metropolitan District Commission Sewer Datum. The four curves provided on each figure represent the outfall system capacity of the indicated outfalls operating in parallel and at design mean low tide, mean sea level, mean high tide, and 10-year storm tide elevations, respectively. These curves have been developed from a computer model of the existing harbor outfall system, which has been calibrated from level monitoring and flow data obtained from plant operating records.

1.3 ENVIRONMENTAL IMPLICATIONS

Any decision to divert the flow back to Boston Harbor from the new outfall location should take into consideration the potential for detrimental effects on the Boston Harbor ecosystem and public health. The Court Order in the Boston Harbor case required construction and use of Outfall TO1 based on the scientific consensus that Boston Harbor would continue to suffer environmental degradation as long as the effluent was discharged into the sensitive, shallow, near-shore waters. Scientists anticipate continued improvements in the harbor ecosystem after the effluent is removed from the harbor via Outfall TO1. Restricted shellfish beds should gradually re-open, the diversity of the benthic community should continue to increase, offensive

Figure 1-1: Deer Island Teatment Plant Flow Percentile Analysis

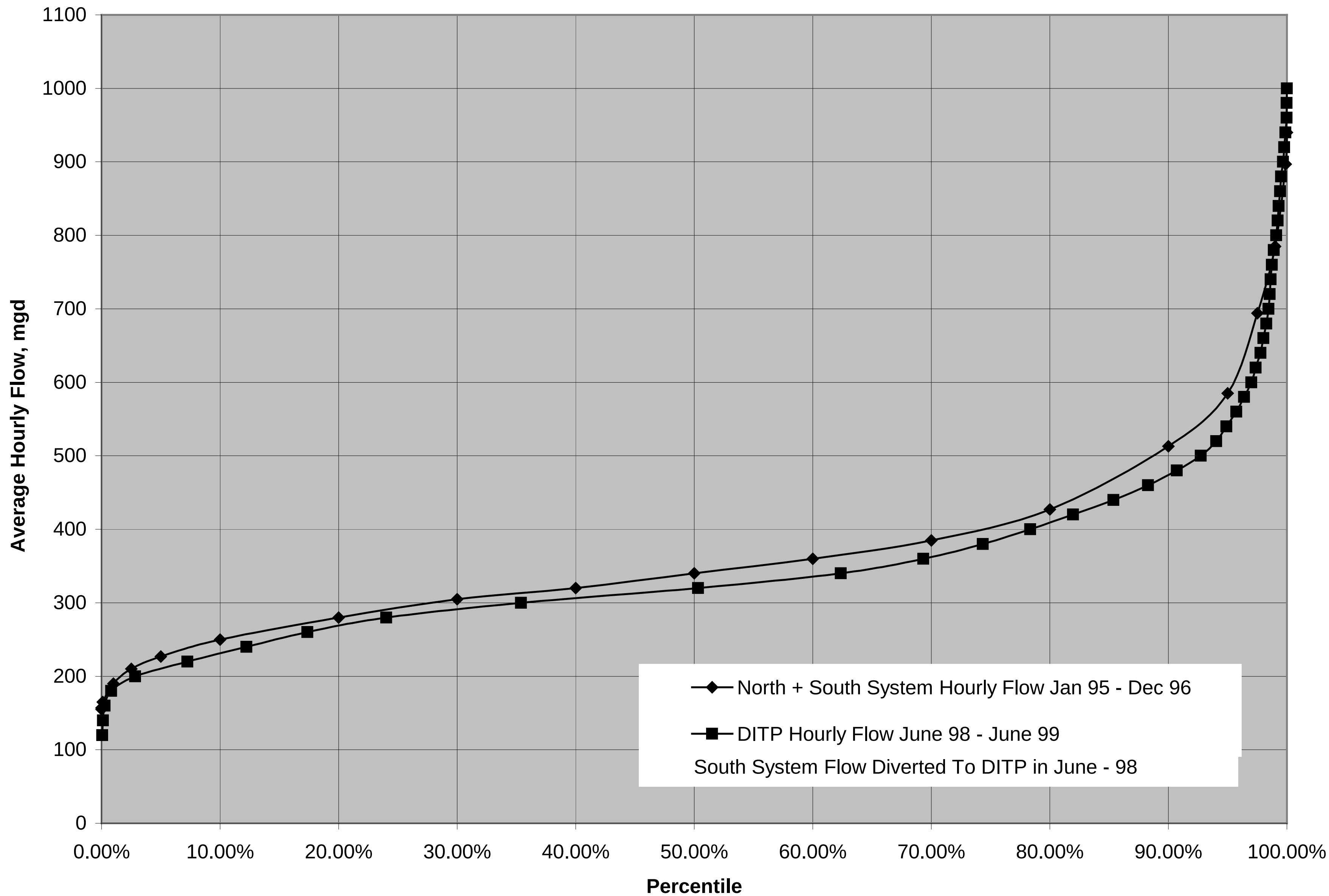


Figure 1-2: Capacity of Existing Harbor Outfalls 001 + 002

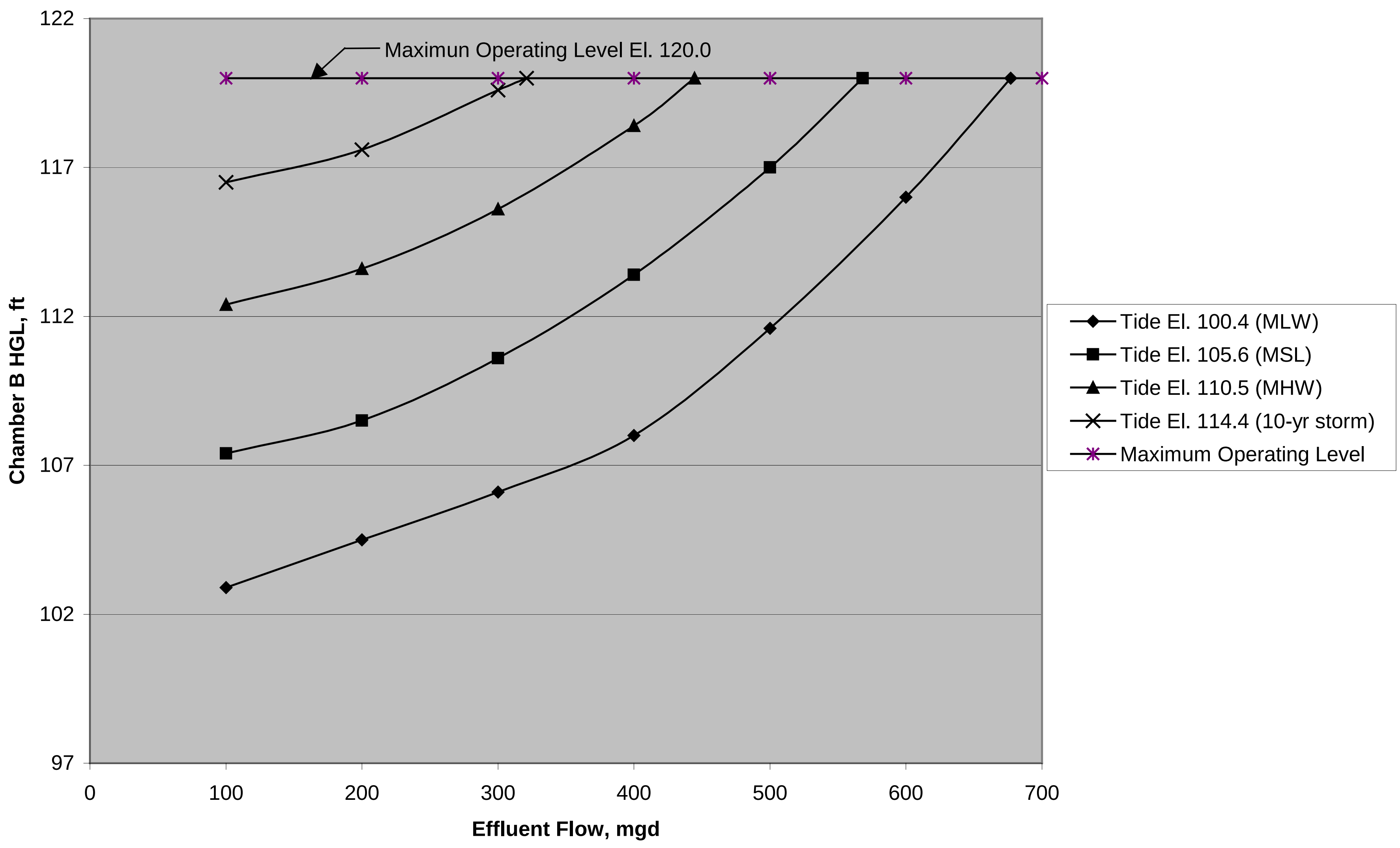


Figure 1-3: Capacity of Existing Harbor Outfalls 001 + 002 + 004

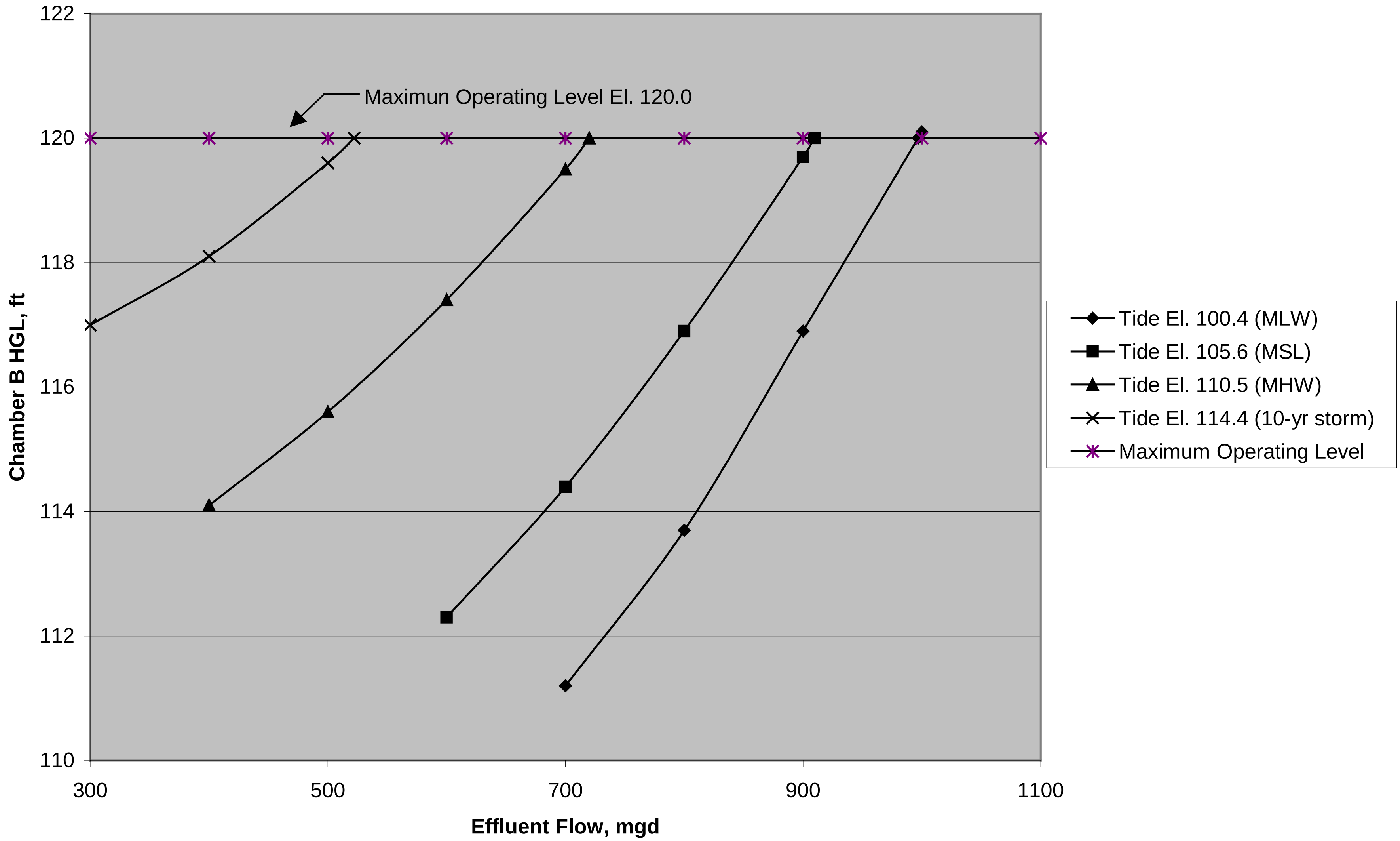
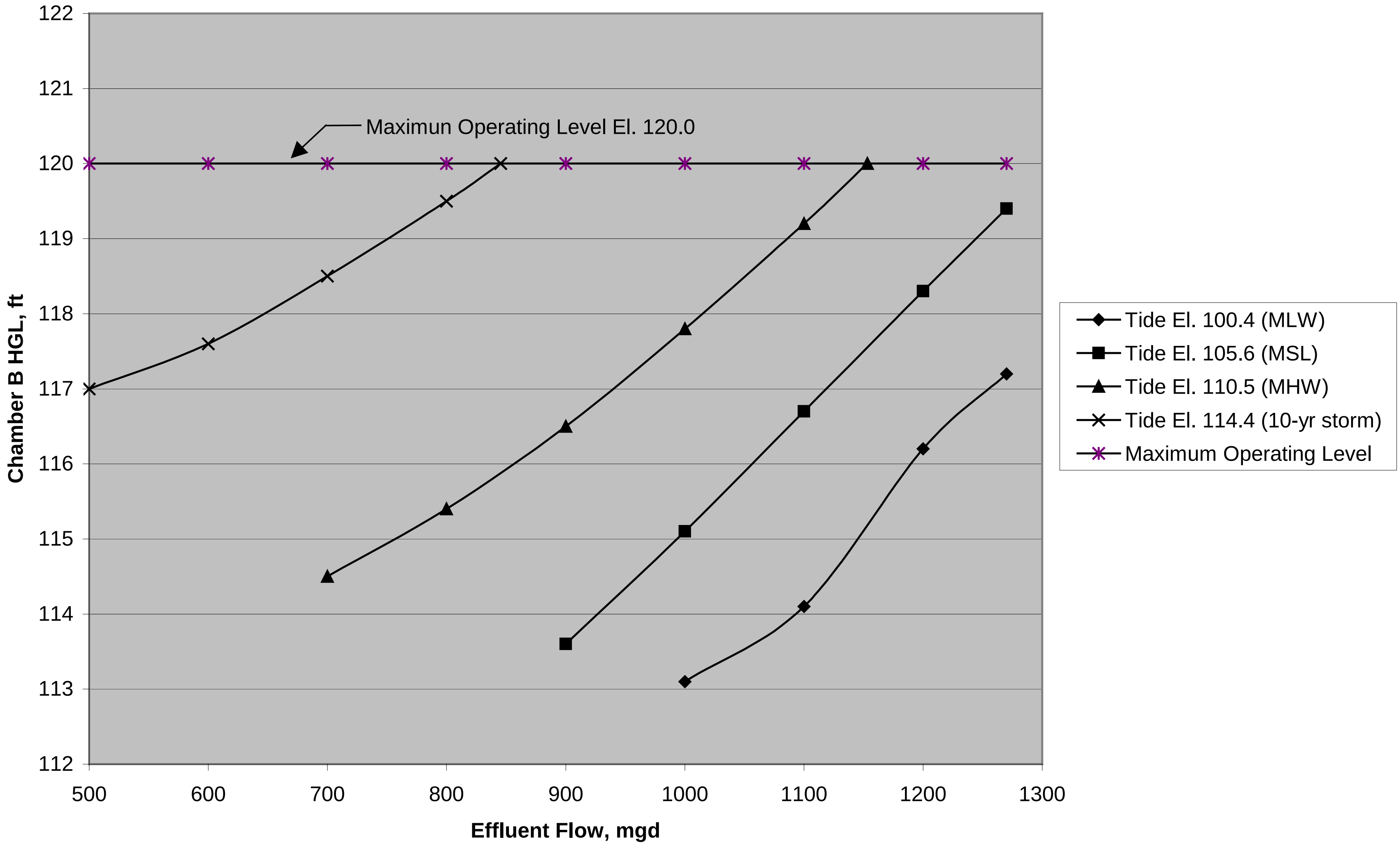


Figure 1-4: Capacity of Existing Outfalls 001 + 002 +004 + 005



slicks should disappear and eelgrass could return. Additionally, the potential risk to public health from any failure of a treatment plant located so close to populated areas, however unlikely, will be greatly minimized.

Diversion of the effluent discharge into Boston Harbor will threaten the continued recovery of the ecosystem. One particular concern will be the effect of excess nitrogen on Boston Harbor, which is presently eutrified and commonly has nuisance algae blooms and decreased water clarity. Furthermore, a decision to divert must consider that the health of Boston Harbor's large estuarine system is integral to the health of the Massachusetts Bay's ecosystem as a whole.

The decision to divert effluent flow to Boston Harbor must also take into account other disadvantages of using the existing harbor outfall system instead of Outfall TO1. For example, due to the greatly reduced chlorine contact time provided by the short outfalls relative to Outfall TO1, significantly larger amounts of chlorine will be required to provide disinfection in the harbor outfall system. Additionally the DITP dechlorination facilities that will be used with Outfall TO1 discharge cannot be used with the existing harbor discharge. Also, the receiving water dilution factors associated with the harbor outfall system components are significantly less than those of Outfall TO1. Finally, the discharge capacity of the existing harbor outfall system is less than the capacity of Outfall TO1, which will result in increased potential for combined sewer overflows elsewhere in the sewer system.

SECTION TWO
FLOW DIVERSION PLAN

The Flow Diversion Plan consists of steps necessary to divert Deer Island Treatment Plant (DITP) effluent flow from outfall TO1 to the existing harbor outfall system. Protocol includes advance preparation activities, establishing the diversion flow path, identifying the gate line-up and gate opening sequence, and estimating the implementation time required for flow diversion. The flow path configuration and gate arrangement described in the flow diversion plan are shown in Figures 2-1 and 2-2. These figures provide the equipment tag numbers referenced in the gate line-up and gate opening sequence.

The Flow Diversion Plan would be implemented by the MWRA upon direction from the EPA and DEP to shut down Outfall TO1. All on-island facilities involved in the flow diversion (e.g. gates, stop logs, valves, etc.) will be regularly exercised and maintained. The Harbor Outfall System Maintenance Plan developed to enable future flow diversion is described in Section 3. In conjunction with the flow diversion, Outfall TO1 would be shut down and preserved for future use. The Outfall TO1 Shutdown and Preservation Plan is described in Section 4.

The Flow Diversion Plan describes two distinct procedures (direct and phased) to achieve flow diversion from outfall TO1 to the harbor outfall system. The direct flow diversion procedure described in Section 2.2, diverts flow from Outfall TO1 to the harbor outfall system in one continuous step. The phased flow diversion procedure described in Section 2.3, diverts a portion of the total plant effluent flow to support Outfall TO1 diffuser port capping. Maintaining a minimum flow rate through Outfall TO1 would minimize the amount of seawater intrusion during capping of the diffuser ports. Minimizing seawater intrusion would in-turn minimize marine growth potential within Outfall TO1 once diversion is complete and Outfall TO1 remains idle for a period of time.

2.1 ADVANCE PREPARATION ACTIVITIES

Once the MWRA has been directed to divert flow from Outfall TO1 to the harbor outfall system, necessary advance preparation activities will be initiated. These activities are identified below:

- Conduct a coordination meeting to review activities necessary to implement flow diversion (e.g., staff and equipment resources, access requirements to align gates, lockout/tagout of gates).
- Review the flow diversion procedure and the associated implementation time required to complete each step.
- Perform a walk-through of the gate line-up and flow diversion sequence.
- Review the protocol for plant process and support systems impacted by flow (e.g., W3H, W3L, W6, effluent sampling, effluent disinfection flash mixing, disinfection basin scum, effluent dechlorination in Outfall TO1, outfall bypass conduit dewatering).
- Determine the number of harbor outfalls necessary to initiate the diversion based on tide and flow conditions.
- Check and calibrate the level monitoring equipment at Chamber B that would be used to determine available outfall capacity and the need for additional outfalls to be placed in service.
- Disinfect stored water present in the outfall box conduit with chlorine solution injections into Chambers A, B, and C prior to removing isolation gates between chambers and outfalls. This activity would disinfect the stored water in the isolated on-shore portion of the outfall system prior to discharge when the isolation is removed.

2.2 DIRECT FLOW DIVERSION PROCEDURE

The direct flow diversion procedure supports a shutdown of Outfall TO1 in a short time period. This flow diversion procedure is independent of any Outfall TO1 diffuser port capping activities. The flow path configuration, gate line-up, and sequence of activation established for direct flow diversion are provided below.

Flow Path Established To Enable Direct Flow Diversion

The plant effluent flow path from the DITP to the existing harbor outfall system is shown in Figures 2-1 and 2-2. This flow path consists of the following flow segments between the disinfection basin influent channel and the harbor outfalls:

1. Plant flow from the disinfection basin influent channel enters Basins 1 and 2 through the associated influent sluice gates and flash mixers.

2. Plant flow entering basin 1 passes northward to the end and exits the basin beneath the launders through the end sluice gates. The flow from Basin 1 then enters Basin 2 through the end sluice gates and passes through Basin 2 in the reverse direction (southward) to the outfall bypass drop shaft.

3. Plant flow entering Basin 2 from the disinfection basin influent channel short circuits westward to the outfall bypass drop shaft.

4. From the outfall bypass drop shaft (southwest corner of Basin 2), plant effluent passes through a pressure conduit segment to a riser shaft (adjacent to Reactor Battery A).

5. From the riser shaft (adjacent to Reactor Battery A), plant effluent passes southward through an open channel conduit segment to a drop shaft (adjacent to Primary Battery D).

6. From the drop shaft (adjacent to Primary Battery D), plant effluent passes westward through a pressure conduit segment beneath the length of the primary cross gallery.

7. From the primary cross gallery, plant effluent passes southward through a pressure conduit segment beneath Primary Battery D.

8. From beneath Primary Battery D, plant effluent passes westward through a drop shaft and pressure conduit segment to Chamber B.

9. From Chamber B, plant effluent is split between Chambers A and C. Dry weather flows are discharged through Chamber C. Wet weather flows exceeding the capacity of Chamber C require activation of Chamber A and Outfall 005.

Direct Flow Diversion Gate Line-up and Sequence of Activation

The gate line-up and sequence of activation required to achieve flow diversion from the DITP to the harbor outfall system are provided in Table 2.1. The gate opening sequence represents the step-by-step process to be followed in order to implement flow diversion and address impacts on

TABLE 2.1: DIRECT FLOW DIVERSION SEQUENCE OF GATE ACTIVATION

STEP	ACTION	LOCATION
	Prepare Harbor Outfall System	
1	Remove stop logs	Chamber B
2	Remove stop logs	Chamber C in 12 ft x 10 ft box conduit
3	Remove redundant stop logs	Between Chamber C and Outfalls 001 and 002
4	Check that sluice gate is closed	Outfall 004
5	Remove stop logs	Between Chamber C and Outfall 004
6	Remove stop logs	Chamber A in 12 ft x 10 ft box conduit
7	Remove redundant stop logs	Between Chamber A and Outfall 005
8	Check that only one barrier gate remains for isolation	Each of the four outfalls
9	Check that the liquid level is greater or equal to the centerline	Upstream of barrier gates * Equal pressure on both sides of the barrier gates will assist in removal and prevent inrush of seawater and debris
10	Open sluice gate to equalize the pressure	Outfall 004
11	Remove barrier stop logs	Outfall 002
12	Remove barrier stop logs	Outfall 001
13	Check that the flow path is clear and that flow can be accommodated	From Chamber B to Outfalls 001, 002, and 004
	Isolate W6 System to Alternate Source and Sink	
14	Open sluice gate [CE:W6.SG-2]	Between W6 supply line and Secondary Clarifier Battery A effluent channel
15	Open sluice gate [CE:W6.SG-1]	Between W6 return line and Secondary Clarifier Battery A effluent channel
16	Close sluice gate [HC:W6.SG-1]	Between W6 supply line and plant water box adjacent to Disinfection Effluent Channel 2
17	Close sluice gate [HC:W6.SG-2]	Between W6 return line and Disinfection Effluent Channel 2
18	Install stop log sections [CA:BYP.RG-9] to crown elevation 136.0	Downstream end of Secondary Battery A effluent channel
	Secure Hydropower Facility	
19	Stop turbines	Hydropower Facility
20	Close bulkhead intake gates [DC:HTG.IG-1 and 2]	Hydropower Facility
21	Dewater	Isolated area of Hydropower Facility
	Secure W3 System for Stop Log Removal	
22	Open sluice gates [HC:W3.SG-1 and 2]	Between Disinfection Effluent Channel 1 and plant water box
23	Open sluice gate [HC:W3.SG-3]	Between the plant water box and the buried 60-inch line to the outfall bypass drop shaft

TABLE 2.1: DIRECT FLOW DIVERSION SEQUENCE OF GATE ACTIVATION (Continued)

STEP	ACTION	LOCATION
24	Close sluice gate [HC:W3.SG-4]	Between the outfall bypass drop shaft buried 60-inch line to the plant water box
25	Stop W3L pumping	* This will interrupt primary sludge dilution water to gravity thickeners, foam spray water to secondary reactors and clarifiers and LOX vaporizer water to the Cryogenic Facility
26	Stop hose gate washdown activities , pipeline pigging and flushing activities	**Plantwide**
27	Connect hose gates to create a W3H recirculation loop	**Adjacent to the east side of Reactor A outfall bypass conduit**
28	Reduce W3H demand to one pump and stop remaining W3H pumps	* This will impact service to the hot flushing water, scum flushing water, sampler flushing water, plantwide piping systems, plantwide hosegates, and residuals area polymer systems
29	Close sluice gates [DA:BYP.SG-1 and 2]	Outfall bypass conduit
30	Monitor W3H drawdown to support removal of stop logs [CA:BYP.RG-2 and 10]	Bypass conduit between the drop shaft and riser shaft
31	Remove stop log [CA:BYP.RG-2]	Bypass conduit
32	Remove stop log [CA:BYP.RG-10]	Bypass conduit
33	Open sluice gate [HC:W3.SG-4]	Between outfall bypass drop shaft and buried 60-inch line to the plant water box * This will initiate flow through the outfall bypass conduit and the supply W3 manifold
34	Start W3H pumps to meet plant demand	From PICS
35	Start W3L pumps to meet plant demand	From PICS
	Checkout and Test Outfall Bypass Sampler	
36	Test and calibrate final effluent sampler	Primary cross gallery adjacent to Primary Battery D. * This location has been used for final effluent monitoring for more than 4 years
	Secure the SBS System - Immediately prior to flow diversion	
37	Stop sodium bisulfite feed to Outfall T01 and protect SBS System from associated impacts	Disinfection gallery intermediate level and SBS valve chamber east of Hydropower Facility

TABLE 2.1: DIRECT FLOW DIVERSION SEQUENCE OF GATE ACTIVATION (Continued)

STEP	ACTION	LOCATION
	Initiate Flow Diversion	
38	Open sluice gates [DA:EFF.SG-1 and 2]	Disinfection Basin 1
39	Open sluice gates [DA:EFF.SG-3 and 4]	Disinfection Basin 2
40	Open sluice gates [DA:EFF.SG-9 and 10]	Between Disinfection Effluent Channel 1 and Disinfection Effluent Channel 2 * In order to lower head in disinfection basins prior to flow diversion
41	Open sluice gates [DA:BYP.SG-1 and 2]	Between Disinfection Basin 2 and the outfall bypass drop shaft
42	Close sluice gates [DA:EFF.SG-9 and 10]	Between Disinfection Effluent Channel 1 and Disinfection Effluent Channel 2 * This isolates flow from Outfall TO1 all flow is now diverted

plant operation. Figure 2-1 and 2-2 show the equipment tag numbers provided for the gates indicated in the sequence of activation. Some of the gates or activities included in this list may constitute existing conditions and require confirmation only. The estimated implementation time to complete the sequence of activation is provided in Section 2.4. Should plates be installed on Outfall 001 diffusers, plates would need to be removed prior to start-up of the Outfall 001; otherwise, flow would not exit the outfall. This will extend the estimated implementation time of flow diversion.

2.3 PHASED FLOW DIVERSION PROCEDURE

Phased flow diversion to the harbor outfalls is performed to support capping of Outfall TO1 diffuser ports under flowing conditions. This procedure maintains a minimum flow to Outfall TO1 and diverts the balance to the existing on-island outfalls. Capping of diffuser ports under flow is an option discussed in Section 4 of this plan to minimize seawater intrusion into Outfall TO1 during shutdown procedures. Phased flow diversion is dependent upon many factors and could involve an implementation period of between three and six weeks to complete. Based on this implementation time, required coordination with plant operations, and the diurnal and weather related plant flow conditions, it is recommended that the hydropower facility be taken off-line prior to flow diversion.

This procedure assumes all plant flow passes through Disinfection Basins 1 and 2 in parallel, over the basin effluent weir crest El. 141.3, and bypassing the hydropower facility via the overflow weir crest El. 139.5 to Outfall TO1. Therefore, the overflow weir crest would control the liquid level in Disinfection Effluent Channel 1.

To initiate phased flow diversion, the connection between Disinfection Effluent Channel 1 and the outfall bypass conduit would be made via the plant water box and 60-inch W3 line. The W3 sluice gate in the plant water box would be throttled to control the flow diversion and maintain adequate flow to Outfall TO1 to prevent seawater intrusion. The capacity of the W3 line, is approximately 130-mgd, corresponding to a 14-foot differential head between Disinfection Effluent Channel 1 and the outfall bypass conduit adjacent to Reactor Battery A.

As the proportion of flow diverted to the harbor outfall system increases toward the capacity of the 60-inch W3 line, one of the two 10-foot by 14-foot self-contained sluice gates isolating Disinfection Basin 2 from the outfall bypass drop shaft could be partially opened. A 2-foot sluice gate opening would equal the cross-sectional area of the 60-inch W3 line.

Flow Path Established to Enable Phased Flow Diversion

The phased diversion flow path is similar to that presented in Section 2.2 with the following variations:

1. Plant flow from the disinfection basin influent channel enters Basins 1 and 2 through the associated influent sluice gates and flash mixers.
2. Plant flow entering Basins 1 and 2 will pass northward to the end and exit the basins via the effluent weirs at crest El. 141.3. The flow from Disinfection Effluent Channel 1 will enter the plant water box and 60-inch W3 line to the outfall bypass drop shaft.
3. Once the W3 line capacity is reached, one of the two sluice gates isolating Disinfection Basin 2 from the outfall bypass drop shaft will be partially opened and continue to be adjusted in a controlled manner. This will allow plant flow entering Basin 2 from the

disinfection basin influent channel to short circuit westward to the outfall bypass drop shaft.

4. From the outfall bypass drop shaft (southwest corner of Basin 2), plant effluent will pass through a pressure conduit segment to a riser shaft (adjacent to Reactor Battery A).
5. From the riser shaft (adjacent to Reactor Battery A), plant effluent will pass southward through an open channel conduit segment to a drop shaft (adjacent to Primary Battery D).
6. From the drop shaft (adjacent to Primary Battery D), plant effluent will pass westward through a pressure conduit segment beneath the length of the primary cross gallery.
7. From the primary cross gallery, plant effluent will pass southward through a pressure conduit segment beneath Primary Battery D.
8. From beneath Primary Battery D, plant effluent will pass westward through a drop shaft and pressure conduit segment to Chamber B.
9. From Chamber B, plant effluent will split between Chambers A and C. Dry weather flows will be discharged through Chamber C. Wet weather flows exceeding the capacity of Chamber C would require activation of Chamber A and Outfall 005.

Phased Flow Diversion Gate Line-up and Sequence of Activation

The gate line-up and sequence of activation required to achieve phased flow diversion from the DITP to the harbor outfall system are provided in Table 2.2. The gate opening sequence represents the step-by-step process to be followed in order to implement flow diversion and address impacts to plant operation. The equipment tag numbers provided for the gates indicated in the sequence of activation are shown on Figures 2-1 and 2-2. Some of the gates or activities included in this list may constitute existing conditions and require confirmation only. The implementation time estimated to complete the sequence of activation is provided in Section 2.4.

TABLE 2.2: PHASED FLOW DIVERSION SEQUENCE OF GATE ACTIVATION

STEP	ACTION	LOCATION
	Prepare Harbor Outfall System	
1	Remove stop logs	Chamber B
2	Remove stop logs	Chamber C in 12 ft x 10 ft box conduit
3	Remove redundant stop logs	Between Chamber C and Outfalls 001 and 002
4	Check that sluice gate is closed	Outfall 004
5	Remove stop logs	Between Chamber C and Outfall 004
6	Remove stop logs	Chamber A in 12 ft x 10 ft box conduit
7	Remove redundant stop logs	Between Chamber A and Outfall 005

TABLE 2.2: PHASED FLOW DIVERSION SEQUENCE OF GATE ACTIVATION (Continued)

STEP	ACTION	LOCATION
8	Check that only one barrier gate remains for isolation	Each of the four outfalls
9	Check that the liquid level is greater or equal to the centerline	Upstream of barrier gates * This will assist in removal and prevent inrush of seawater and debris
10	Open sluice gate to equalize the pressure	Outfall 004
11	Remove barrier stop logs	Outfall 002
12	Remove barrier stop logs	Outfall 001
13	Check that the flow path is clear and that flow can be accommodated	From Chamber B to Outfalls 001, 002, and 004
	Isolate W6 System to Alternate Source and Sink	
14	Open sluice gate [CE:W6.SG-2]	Between W6 supply line and Secondary Clarifier Battery A effluent channel
15	Open sluice gate [CE:W6.SG-1]	Between W6 return line and Secondary Clarifier Battery A effluent channel
16	Close sluice gate [HC:W6.SG-1]	Between W6 supply line and plant water box adjacent to Disinfection Effluent Channel 2
17	Close sluice gate [HC:W6.SG-2]	Between W6 return line and Disinfection Effluent Channel 2
18	Install stop log sections [CA:BYP.RG-9] to crown elevation 136.0	Downstream end of Secondary Battery A effluent channel
	Secure Hydropower Facility	
19	Stop turbines	Hydropower Facility
20	Close bulkhead intake gates [DC:HTG.IG-1 and 2]	Hydropower Facility
21	Dewater	Isolated area of Hydropower Facility
	Secure W3 System for Stop Log Removal	
22	Open sluice gates [HC:W3.SG-1 and 2]	Between Disinfection Effluent Channel 1 and plant water box
23	Open sluice gate [HC:W3.SG-3]	Between the plant water box and the buried 60-inch line to the outfall bypass drop shaft
24	Close sluice gate [HC:W3.SG-4]	Between the outfall bypass drop shaft buried 60-inch line to the plant water box

TABLE 2.2: PHASED FLOW DIVERSION SEQUENCE OF GATE ACTIVATION (Continued)

STEP	ACTION	LOCATION
25	Stop W3L pumping	* This will interrupt primary sludge dilution water to gravity thickeners, foam spray water to secondary reactors and clarifiers and LOX vaporizer water to the Cryogenic Facility
26	Stop hose gate washdown activities , pipeline pigging and flushing activities	**Plantwide**
27	Connect hose gates to create a W3H recirculation loop	**Adjacent to the east side of Reactor A outfall bypass conduit**
28	Reduce W3H demand to one pump and Stop remaining W3H pumps	* This will impact service to the hot flushing water, scum flushing water, sampler flushing water, plantwide piping systems, plantwide hosegates, and residuals area polymer systems
29	Close sluice gates [DA:BYP.SG-1 and 2]	Outfall bypass conduit
30	Monitor W3H drawdown to support removal of stop logs [CA:BYP.RG-2 and 10]	Bypass conduit between the drop shaft and riser shaft
31	Remove stop log [CA:BYP.RG-2]	Bypass conduit
32	Remove stop log [CA:BYP.RG-10]	Bypass conduit
33	Open sluice gate [HC:W3.SG-4]	Between outfall bypass drop shaft and buried 60-inch line to the plant water box * This will initiate flow through the outfall bypass conduit and the supply W3 manifold
34	Start W3H pumps to meet plant demand	From PICS
35	Start W3L pumps to meet plant demand	From PICS
	Checkout and Test Outfall Bypass Sampler	
36	Test and calibrate final effluent sampler	Primary cross gallery adjacent to Primary Battery D. * This location has been used for final effluent monitoring for 4 years
	Secure the SBS System – Immediately prior to flow diversion	
37	Stop sodium bisulfite feed to Outfall T01 and protect SBS System from associated impacts	Disinfection gallery intermediate level and SBS valve chamber east of Hydropower Facility

TABLE 2.2: PHASED FLOW DIVERSION SEQUENCE OF GATE ACTIVATION (Continued)

<table>
<tr><th>STEP</th><th>ACTION</th><th>LOCATION</th></tr>
<tr><td></td><td colspan="2">Initiate Flow Diversion</td></tr>
<tr><td></td><td colspan="2">With the hydropower facility off-line, the overflow weir crest El. 139.5 controls the liquid level in Disinfection Effluent Channel 1. The head differential created between the plant water box and the outfall bypass conduit high point adjacent to Reactor Battery A allows flow diversion through the 60-inch W3 line. The W3 sluice gate in the plant water box would be throttled to divert a portion of the flow to the harbor outfall system. A minimum flow of 200-mgd must pass through the Outfall TO1 to prevent seawater intrusion. Note that the W3 gate would need to be throttled to the 10% open position when plant flow drops below 200-mgd.</td></tr>
<tr><td>38</td><td>Throttle sluice gate [HC:W3.SG-3]</td><td>Between the plant water box and the outfall drop shaft through the 60-inch W3 line</td></tr>
<tr><td></td><td colspan="2">At the assumed 14-foot differential head condition controlled by the overflow weirs, the sluice gate throttling positions, based on total plant flow, should be as follows:
<table>
<tr><th>Total Plant Flow, mgd</th><th>Throttling Position, % OPEN</th></tr>
<tr><td>0-200</td><td>10</td></tr>
<tr><td>201-300</td><td>20</td></tr>
<tr><td>301-400</td><td>40</td></tr>
<tr><td>401-500</td><td>100</td></tr>
</table>
Depending on diurnal flow conditions, this will allow capping of up to 50% of the open diffuser ports.</td></tr>
<tr><td>39</td><td>Throttle sluice gate [DA:BYP.SG-1]</td><td>Between Disinfection Basin 2 and outfall bypass drop shaft</td></tr>
<tr><td></td><td colspan="2">Throttling of sluice gate DA:BYP.SG-1 is based on sluice gate HC:W3.SG-3 at 100% open and the following relationship between total plant flow and percent of diffuser ports capped:
<table>
<tr><th>Total Plant Flow
Mgd</th><th>Diffuser ports
% Capped</th><th>Throttling Position
% OPEN</th></tr>
<tr><td>501-900</td><td>25</td><td>10</td></tr>
<tr><td>901-1000</td><td>25</td><td>20</td></tr>
<tr><td>1001-1100</td><td>25</td><td>30</td></tr>
<tr><td>501-700</td><td>50</td><td>10</td></tr>
<tr><td>701-900</td><td>50</td><td>20</td></tr>
<tr><td>901-1000</td><td>50</td><td>30</td></tr>
<tr><td>1001-1100</td><td>50</td><td>50</td></tr>
<tr><td>401-500</td><td>75</td><td>10</td></tr>
<tr><td>501-700</td><td>75</td><td>20</td></tr>
<tr><td>701-900</td><td>75</td><td>30</td></tr>
<tr><td>901-1000</td><td>75</td><td>50</td></tr>
<tr><td>1001-1100</td><td>75</td><td>100</td></tr>
</table></td></tr>
</table>

TABLE 2.2: PHASED FLOW DIVERSION SEQUENCE OF GATE ACTIVATION (Continued)

STEP	ACTION	LOCATION
	A portion of the flow will short circuit from Disinfection Basin 2 to the outfall bypass drop shaft when sluice gate DA: BYP.SG-1 is opened.	
40	Close sluice gate [DA:BYP.SG-1] when total plant flow drops below 500-mgd and less than 50% of the diffuser ports have been capped. If more than 50% of the diffuser ports have been capped, then throttle sluice gate [DA:BYP.SG-1] according to the table provided in Step 39.	Between Disinfection Basin 2 and outfall bypass drop shaft
41	Open sluice gates [DA:EFF.SG-3 and 4]	Between Disinfection Basin 2 and Disinfection Effluent Channel 1 to equalize liquid level.
42	Open sluice gates [DA:EFF.SG-1 and 2]	Between Disinfection Basin 1 and Disinfection Effluent Channel 1 to equalize liquid level.
43	Once all diffuser ports have been capped with Outfall TO1 flow discharging through port cap nozzles, coordinate final port cap nozzle closure with SBS carrier water flowrate through parallel 10-inch lines in to Outfall TO1.	SBS carrier water flowrate can be controlled in the range 0-3,100 gpm to support final port cap closure.
43	Close sluice gates [DA:BYP.SG-9 and 10]	Between Disinfection Effluent Channel 1 and Disinfection Effluent Channel 2 * All flow is now diverted and Outfall TO1 is isolated from the plant effluent flow.

2.4 IMPLEMENTATION TIME REQUIRED TO ACHIEVE FLOW DIVERSION

The protocols provided to implement each method of flow diversion involve thorough preparation and close coordination to carefully align and operate the required equipment. The estimated duration for these activities for the direct flow diversion and phased flow diversion are provided in Tables 2.3 and 2.4, respectively. Note that the gate opening sequence under the phased flow diversion plan is coordinated with concurrent diving and diffuser port capping activities.

TABLE 2.3: ESTIMATED IMPLEMENTATION TIME REQUIRED FOR DIRECT FLOW DIVERSION ACTIVITIES

Activity	**Duration, days**
Advanced Preparation	2 – 3
Gate Line-up	1 – 2
Gate Opening Sequence	2 – 4
Total Duration	5 – 9

TABLE 2.4: ESTIMATED IMPLEMENTATION TIME REQUIRED FOR PHASED FLOW DIVERSION ACTIVITIES

Activity	**Duration, days**
Advanced Preparation	5 – 10
Gate Line-up	1 – 2
Gate Opening Sequence*	14 – 28
Total Duration	20 – 40

* Concurrent diving and diffuser port capping operation

2.5 FLOW DIVERSION RECOMMENDATIONS

M&E recommends the direct flow diversion procedure to divert flow from Outfall TO1 to the harbor outfall system based on the following points:

- Less time required to implement and complete compared with the phased flow diversion procedure.
- Less effort and coordination required with plant operations resources compared with the phased flow diversion procedure.
- Eliminates the need for and difficulty associated with flow monitoring and throttling required by the phased flow diversion procedure to support capping activities.
- Less costly to implement compared with the phased flow diversion procedure.

SECTION THREE
HARBOR OUTFALL SYSTEM MAINTENANCE PLAN

3.1 EXISTING CONDITIONS

Outfall Components

The existing Deer Island Treatment Plant outfall system consists of a series of box conduits, three junction chambers, and four outfall pipes. Figures 3-1 and 3-2 show the layout and relative position of the various outfall components. The onshore components are 12-foot-wide by 10-foot-high reinforced box conduits, which run between Chambers A, B, and C in lengths of approximately 1,000 feet (A to B) and 1,500 feet (B to C). The remainder of the system consists of Outfalls 001, 002, and 004 at Chamber C and Outfall 005 at Chamber A. (Outfall 003 was a temporary outfall that has been plugged and abandoned.) The characteristics of the existing outfall components are shown in Table 3.1.

TABLE 3.1: EXISTING OUTFALL CHARACTERISTICS

	Outfall Number			
	001	**002**	**004**	**005**
Length, feet	2,565	2,260	500	135
Diameter, feet	10.0	6.29	9.0	9.0
Discharge Elevation, feet	54.7	54.7	97.8	98.0
Number of Open Ports	52[a]	14	1	1
Port Diameter, feet	1.69	1.67	9.00	9.00
Chamber Invert Elevation, feet	98.1	98.1	98.1	103.2
Chamber Overflow Elevation, ft	120.0	120.0	120.0	125.0
Year Constructed	1959	1917[b]	1959	1959

a – Five of the 52 ports are buried

b – Original brick outfall built in 1896; iron section in 1917

Most Recently Known Conditions

The most recently determined conditions of the existing outfall system are outlined in the 1992 lead design engineer's *Emergency Outfall Study* (Metcalf & Eddy), the 1993 DP-38 project design engineer's *Existing Outfall Modifications Report* (Sverdrup), the 1994 DP-38 *Outfall Crack Repair Inspection Report* (Sverdrup), and the 1997 LDE *Unprotected Outfall Inspection* (Metcalf & Eddy). Hydraulic and structural analyses performed during the 1992 LDE study revealed that the outfall system routinely experienced overstressing due to internal water pressures and external loadings. The 1992 study recommended repairs to provide the hydraulic capacity for discharge of the new plant's peak flow. A detailed inspection program was then conducted under DP-38 the following year. An inspection dive was performed on March 3, 1993, in Chambers A, B, and C and the connecting conduits. Various cracks were discovered, along with concrete spalling, concrete delamination, and bar support bricks dislodged from the top slab. The cracks were described as hairline to 1.0-inch, mostly transverse to the tunnel axis and located mostly on the slab extending down the walls, and between Chambers B and C. The short- and long-term repair modifications recommended in the 1993 *Existing Outfall Modifications Report* are outlined in Table 3.2. Recommendations that have been implemented to date are shaded.

Repairs were performed on Chambers A, B, and C and their associated conduits between February 11 and 24, 1994. Crack repairs were accomplished by injection of a polyurethane chemical grout. The secondary deficiencies (dislodged bricks and concrete spalling and delamination) were repaired using a polymer repair mortar. All cracks were sealed, including a large floor crack near Chamber B. All areas of deteriorated concrete were satisfactorily repaired. Deformation monitoring points for future reference and inspection were installed at outfall station 10+50 (between stations 10+00 and 11+00, see Figure 3-2). The 1997 follow-up inspection of the unprotected conduit between Chambers A and B showed no change from the 1994 repairs.

TABLE 3.2: RECOMMENDATIONS FOR OUTFALL SYSTEM COMPONENTS (OCTOBER 29, 1993)

Outfall System Component	**Recommendations**	
	Short Term (2-3 Years)	Long Term (3+ Years)
Unprotected conduit between Chamber A and Chamber B	- Restrict backfill weight to 120 pcf. - Reduce future grade from Elevation 125 tp Elevation 122 - Install deformation monitoring points - Prohibit crane loading within 20 feet - Revise Guard House foundations	- Perform test borings and additional structural analysis - Reinforce structures to sustain loads to modern code criteria - Extract concrete cores for testing
Protected conduit between Chamber A and Chamber B	- Repair cracks	- Perform yearly internal inspections - Extract core samples for testing
Chamber A	- Restrict construction loads, trucks and cranes within 20 feet of structure - Erect fence around Chamber A	- Reinforce structure to sustain loads to modern code criteria
Chamber B	- None	- Modify vent shaft
Chamber C	- Restrict construction loads, trucks, and cranes within 20 feet of structure - Erect fence around Chamber C	- Construct wall across north side of chamber connection to abandoned North Metropolitan trunk sewer - Reinforce structure to sustain loads to modern code criteria - Prevent vehicles from passing over the top of the structure - Repair Outfall 002 brick manhole

Source: DP-38 *Existing Outfall Modifications Report*, Sverdrup Civil, Inc., 1993.
Shading = recommendations implemented (as of July 1999).

Inspections of the diffuser sections of Outfalls 001 and 002 were performed between July 26 and 29, 1994. The diffuser section of Outfall 002 has 13 “elliptical scoop” diffuser ports of various sizes and one 48-inch terminus diffuser port (see Figures 3-3 through 3-6). This diffuser section was found to be nonfunctional because a 100-foot section of the outfall conduit had been severed. Although the diffuser section showed no physical defects, the interruption of effluent flow allowed the deposition of sediment and marine fouling. The damaged section of Outfall 002 was repaired and the diffuser section was cleaned out under a 1994 MWRA Sewerage Division contract. The brick access manhole for Outfall 002, south of Chamber C, contains stop log grooves to isolate the outfall. The manhole is in poor condition (cracked) and in need of repair and a cover.

In early May 2000, harbor observations in the area of the main Deer Island outfalls indicated a suspected crack in Outfall 002. Staff proceeded to photograph the surface waters above the main outfall and based on this information, to hire a contract diver to inspect the external condition of Outfall 002. It appears from the video diver inspection that a 3-inch crack (separation) approximately 60 feet long exists in the crown of Outfall 002. The crack is approximately 100 yards from the shoreline. There is effluent percolating from the ground adjacent to the 60-foot section. This situation strongly suggests other (below ground) cracks exist. The breached section was constructed in the late 1800’s and is over 100 years old. This is the same outfall that was breached and repaired several years ago. This new crack is in a different location on the outfall.

The diffuser section of Outfall 001 is constructed of extra-strength, precast, reinforced-concrete, subaqueous-pressure pipe and is approximately 240 feet long. The outfall has 52 diffuser ports, 51 of which are 20-inch-diameter ports while the remaining one is a 30-inch-diameter terminus port (see Figures 3-7 through 3-11). Five of the 20-inch ports were reported as buried in the sediments at various locations along the length of the diffuser section. The inspection also included an internal survey of Outfall 001. The entire diffuser conduit was found to be without structural discrepancies and free of sediment and debris.

Recommendations for the diffuser sections of Outfalls 001 and 002 included:

- No further inspection of Outfall 001 at the time of the report (December 1, 1994)
- Verification that the conduit stays buried

Outfalls 004 and 005 (see Figures 3-12 and 3-13) are visible at low tide and were inspected in 1990 and 1991, respectively. The inspections indicated that the reinforced-concrete pipes were in good condition and exhibited little marine growth and a small amount of sedimentation on the invert of the pipe. A small area of Outfall 005 had exposed rebar approximately 20 feet from the end of the outfall. Outfall 004 is used only in wet weather and has an electric motor operator on the sluice gate. There is a custom-fabricated slide gate (by DITP staff) installed at Chamber A, which reduces the flow opening to direct flow towards Outfalls 001 and 002.

3.2: POTENTIAL IMPACTS ON THE HARBOR OUTFALL SYSTEM

The existing harbor outfalls will be shut down in conjunction with the start-up of Outfall T1. Shutting off the flow to the harbor outfalls (001,002, 004, and 005) raises several issues that should be addressed, in addition to the recommendations noted in Table 3.2. The harbor outfall system must be maintained in the event that a future activation is required. Biofouling of the diffusers, sediment build-up in the outfall pipes and around the diffusers are potential causes of reduced capacity within the outfall system. Odor, corrosion, system inspection and preventative maintenance of equipment are additional issues that should be addressed. These issues are discussed below in the contexts of short-term and long-term maintenance.

3.3 RECOMMENDATIONS FOR HARBOR OUTFALL MAINTENANCE

This section summarizes Metcalf & Eddy's recommendations for maintenance of the harbor outfall system. A full inspection of the onshore and offshore components of the harbor outfall system is recommended as soon as practicable after the transfer of flow to Outfall TO1 to definitively record the base conditions of the harbor outfall system by component. The examination should focus on structural integrity and the presence of biofouling or sediment. Specific recommendations for the onshore and offshore components are described below.

Recommendations for Onshore Components

Dewatering of the onshore chambers and conduits is recommended prior to the baseline and any further inspections to facilitate the most thorough evaluation possible of their condition. Dewatering can be accomplished by installing stop logs into each outfall stop log chamber to isolate the onshore components. A dewatering sump pump could then be lowered into the outfall conduit through the access manhole adjacent to the west wall of Primary Battery D. The onshore conduit system could be dewatered to El. 120.0 by pumping the contents into Primary Battery D's influent channel.

The installation of low-leakage, fiberglass stop logs in each outfall stop log chamber is recommended as soon as practical once flow is diverted from the current outfall system to the new ocean outfall. These stop logs will minimize the exchange of seawater in the chambers and conduits and will isolate the onshore components of the outfall system from the offshore outfall components. Standard wooden stop logs often have significant leakage and swell when immersed, making them difficult or impossible to remove. DITP staff recently procured reinforced-fiberglass stop logs with tightly sealing rubber gaskets under CP-171 for isolation of primary clarifier effluent channels. Experience with this type of stop log thus far at DITP, and at other installations surveyed, shows that the rate of leakage is low (comparable to that of a gate). In addition, the installation and removal of fiberglass stop logs can be accomplished with relative ease, which will be important should the harbor outfall need to be brought quickly back on line. Stop logs and associated stainless steel guides, need to be procured to fit the stop log grooves for each outfall.

Recommendations for short and long-term maintenance of the onshore components are included in Table 3.3. Other recommendations for the onshore components include provisions to maintain the capacity of the existing outfall system. The system capacity can be reduced by structural damage or by the intrusion of seawater, which can produce biological growth. Chamber C is equipped with an electrically operated sluice gate for control of flow to Outfall 004. Chamber A is equipped with an electrically operated slide plate for control of flow to Outfall 005. This gate, at Chamber A, will be upgraded to an electronically operated sluice gate as part of this plan. Monthly exercise of these control elements is recommended. Additionally monthly exercise of the outfall by-pass conduit effluent sampler and monthly inspection of the ultrasonic level sensors located at Chambers B and C are recommended.

Recommendations for Offshore Components

Various options were investigated for the maintenance of the offshore components of the harbor outfall after it has been shutdown. It is uncertain what degree of flow reduction

TABLE 3.3: RECOMMENDATIONS FOR ON-SHORE OUTFALL COMPONENTS (9/1/99)

On-Shore Outfall Components	Short Term (1-2 Years)	Long Term (2 Years to Year 2020+)
Unprotected conduit between Chamber A and Chamber B	– Take and record measurements from formation monitoring points annually – Perform Internal Inspection annually	– Perform additional structural testing and analysis as required as based upon inspection data – Reinforce and/or repair existing structures to sustain loads as regulated – Perform internal inspections every 2 years and when deformation is evidenced – Perform annual external inspection of finished grade over conduit looking for settlements or sink holes
Protected Conduit between Chamber A and Chamber B	– Perform Internal Inspection annually – Repair cracks and other defects revealed during inspections	– Same as Above
Chamber A	– Perform Internal Inspection annually	– Same as Above
Chamber B	– Perform Internal Inspection annually – Modify vent shaft	– Same as Above
Chamber C	– Perform Internal Inspection annually	– Same as Above – Construct wall across north side of chamber connections to abandoned North Metropolitan Trunk Sewer – Erect Fence around Chamber C – Repair Outfall 002 brick manhole

due to biofouling and sedimentation will occur in these outfalls with no action taken. Careful monitoring will help the MWRA to determine the best course of action in the future. Possible long-term action plans include no action, periodic cleaning of the outfalls, or installation of duckbill check valves. The data collected from outfall inspections will assist MWRA in determining the duration between subsequent inspections and in evaluating the best long-term alternatives for these outfalls.

As noted above, an inspection of the offshore outfall components is recommended as soon as practicable after transfer of flow to Outfall TO1 to determine their background condition. Periodic inspections of the existing outfall pipes should then be performed to assess any changes in their internal and external condition. Diving inspections should assess the structural condition, degree of biofouling, and degree of sedimentation build-up in and around the outfall pipes and support trenches. The diffusers and outfall terminations should be cleaned and sediment excavated as necessary to maintain the capacity of the system. Inspections of the internal components of the outfall system are vital for determining the need for structural repair and sediment removal by mechanical means such as vacuum removal.

Further recommendations for the offshore components of the harbor outfall system have been separated into two categories: outfall pipes with a single terminus (004 and 005) and those with multiple diffusers (001 and 002).

Outfalls 004 and 005

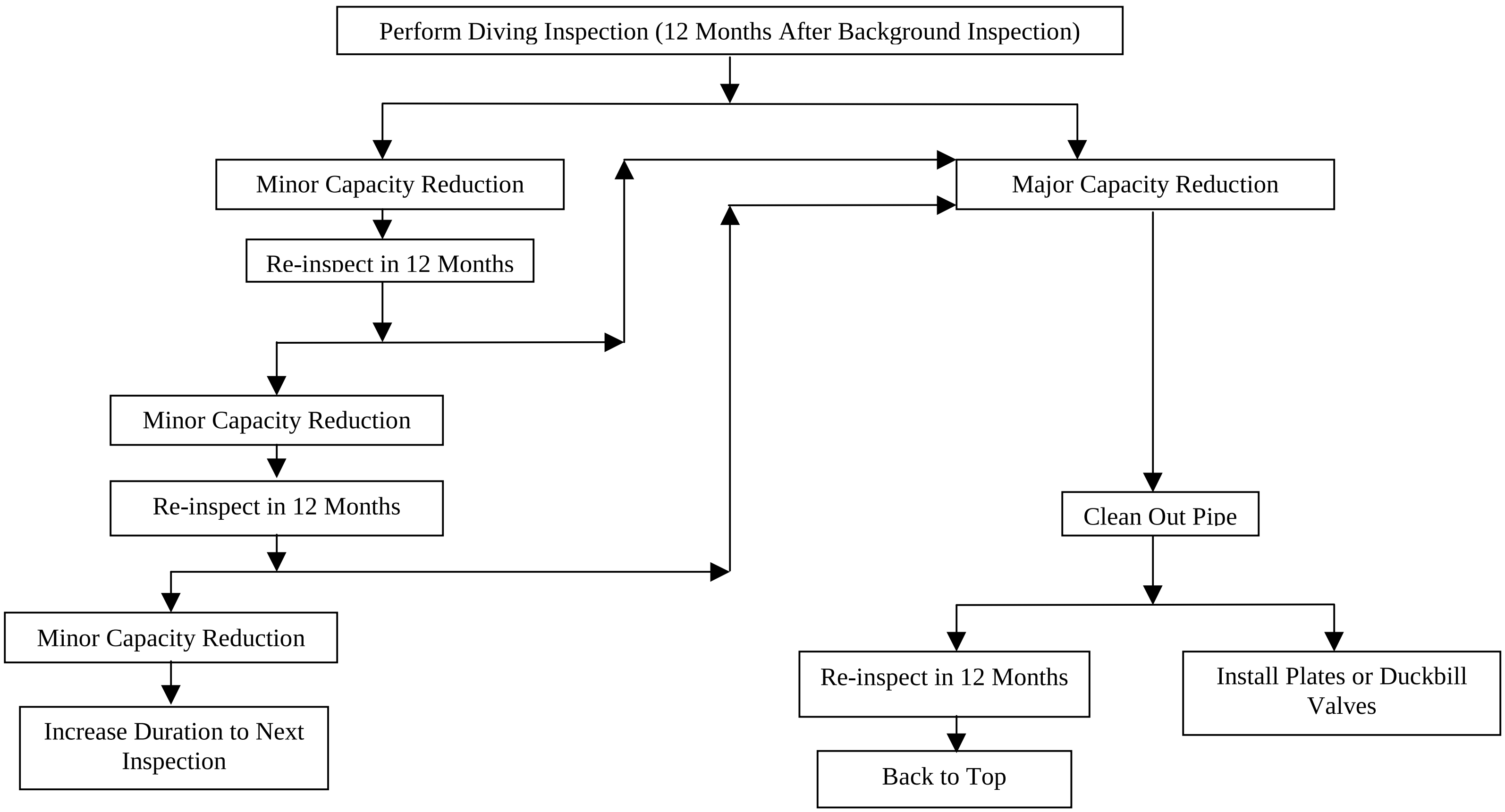
No action is recommended for Outfalls 004 and 005. Outfall 005 is commonly out of service for durations of many months. Visual inspections of the outfall during these non-service periods have indicated that little adverse sedimentation or biological growth has occurred within the pipe. In addition, any accumulated sediment that has collected in the invert of the pipe terminus has been effectively removed as the pipe was reactivated.

Annually inspections of Outfalls 004 and 005 are recommended to determine their structural integrity and the degree of biofouling and sedimentation. If no significant structural, biofouling, or sedimentation problems are noted in the first few inspections, then increasing the period of time between adjacent inspections to at least two years is recommended. Immediate repair of significant structural problems and/or removal of significant quantities of biofouling or sediment is recommended if noted by inspections.

Outfalls 001 and 002

A multi-step approach is recommended for evaluating the long-term maintenance of Outfalls 001 and 002. These outfalls are the most frequently used in the current harbor discharge scheme and would be employed before Outfalls 004 and 005 during a complete or partial flow diversion from the ocean outfall. Monitoring the structural condition and degree of biofouling and sedimentation that occurs in Outfalls 001 and 002 after plant flow has been diverted to the ocean outfall is recommended. Figure 3-14 outlines the recommended approach for maintaining the flow capacity of these two outfalls.

The installation of plates or check valves is recommended if sedimentation or biofouling significantly reduces the capacity of outfalls 001 and 002. Plates or check valves will serve as a physical means of isolating the internal outfall system from the intrusion of sediment and seawater. Duckbill-type check valves are recommended over the traditional "flap-valve" tide gates. This approach would be consistent with the Nut Island outfall contingency design by Montgomery Watson (formerly Havens and Emerson, the CP-152 project design engineer). Some of the advantages of the duckbill check valve are its non-deteriorating rubber design and its inherent flexibility. Duckbill check valves typically require only inches of line pressure to begin opening while they can withstand backpressures greater than 50 feet. Duckbill check valves produce less headloss than comparable flap-valve tidal gates and are not subject to blockage by debris. Pictures of some duckbill check valves are shown in Appendix A.



- Minor Capacity Reduction < 20-25 % Above Background Sedimentation/Biofouling Levels
- Major Capacity Reduction > 25% Above Background Sedimentation/Biofouling Levels

Figure 3-14: Recommended Approach for Flow Capacity Maintenance for Outfalls 001 and 002

The duckbill-type check valve has been used extensively in sewage and stormwater outfall applications and is available in sizes up to 108 inches. These valves can be installed in a variety of orientations (vertical to horizontal). The duckbill valves could be installed on Outfall 001 at the 30-inch terminus and at the 51 existing 20-inch diffuser ports, which are oriented at 45-degree angles. The diffuser ports in Outfall 001 have a 9-inch lip on which the duckbill valves could be clamped (see Appendix A).

The "elliptical scoop" diffuser ports on Outfall 002 are irregular in depth and shape and will require outfall modifications or custom valve configurations, if installation is even feasible on the 82-year-old cast-iron pipe. Dimensional information for the Outfall 002 diffusers does not exist, and an assessment of the condition of the pipe is necessary to determine if alterations are possible to accommodate the duckbill check valves. It is therefore recommended that the initial survey of the outfall system (just after transfer of flow to Outfall TO1) include collection of dimensional data for the Outfall 002 diffusers and an assessment of the condition of the pipe. The Red Valve Corporation has provided a sketch of how the duckbill valves could be installed on these "elliptical scoop" diffusers (Appendix A). Should duckbill installation be determined to be too costly, evaluate the use of plates to isolate the outfall. Note however, plate installation will extend the estimated implementation time of the flow diversion.

If plates or duckbill check valves are to be installed on one or more of the outfalls, then consideration should be given to the complete cleaning of the outfalls and their related components prior to installation, as was done at Nut Island.

Once the decision is made to provide plates or duckbill check valves for one or more outfalls, the design, fabrication, and installation steps would begin. The duration of each of these steps would vary depending upon which outfall is involved. An average estimate to complete each of these steps for the various outfalls is provided in Table 3.4.

TABLE 3.4: ESTIMATED TIME TO DESIGN, FABRICATE, AND INSTALL PLATES OR DUCKBILL CHECK VALVES

	Outfalls 001 and 002
Design	2-3 weeks
Fabrication	14-18 weeks
Installation	3 weeks
Total from NTP	19-24 weeks

NTP = Notice to proceed

SECTION FOUR
OUTFALL TO1 SHUTDOWN AND PRESERVATION PLAN

This section has been prepared by Parsons, Brinckerhoff, Quade and Douglas, Inc. (PB) to identify the activities that are necessary for the shutdown of Outfall TO1. The shutdown of the outfall tunnel for any period of time would be a costly and complex operation, and should not be taken lightly. However, it does appear that the shutdown of the outfall is feasible. The shutdown will require the diversion of the effluent from the new Massachusetts Bay outfall to the existing inner harbor outfalls as described in Section 2.

Two distinct types of Outfall T01 shutdown scenarios have been established. The first is a short-term shut down with the outfall remaining ready to restart and subsequent monitoring programs to measure the extent of diffuser biofouling over time. The second is a long-term shut down where the outfall is isolated from the ocean by capping of the diffuser ports. Diffuser port capping can be accomplished both under effluent flow and no effluent flow conditions. Different procedures for each type of shut down are included in this report.

An important aspect of this outfall preservation plan is the need for ocean diving. Diving in the ocean can be very difficult if the weather does not cooperate. The bad weather typically occurs from mid-October through to the late winter. Bad weather could impact three aspects of this plan – any diving work in the vicinity of the risers necessary to shut the outfall down, any diving work to inspect the diffusers once the outfall is shut down, and diving work associated with outfall re-starting.

Shutdown procedures will vary depending on the duration and the potential for biofouling of the diffuser ports. Once biofouling reaches a threshold level in a short-term shutdown, then cleaning and capping of the diffuser ports would proceed. For purposes of this plan, the biofouling threshold level would be established at a minimum 30-day period or an average 10-percent blockage of the diffuser ports. If conditions allow, monitoring could be used to determine the presence of indicator species. If no biofouling is observed that would interfere with the outfall or diffuser operation, then this initial shutdown phase without capping of the diffuser ports could be extended accordingly, pending subsequent monitoring.

Monitoring for biofouling would consist of observational dives to three representative risers to visually examine the diffuser ports for biofouling. In addition, benthic sampling discs previously placed by several diffusers could be retrieved to examine for biofouling in a laboratory.

4.1 OUTFALL DESCRIPTION

The new Deer Island outfall, Outfall TO1, is an approximately 50,000-foot long, 24.25-foot diameter concrete lined tunnel with 55 riser pipes and associated diffusers, extending north-east from Deer Island into Massachusetts Bay. The tunnel is approximately 240 feet below the sea floor in the diffuser area. The diffuser portion of the tunnel is approximately 6600-feet long, and reduces in diameter along its length from 24.25-feet to less than 5-feet at the easternmost end of the tunnel (Riser locations 1 and 2). This reduction in size is necessary due to hydraulic considerations of the tunnel. The riser pipes are 30-inch diameter fiberglass pipes encased in cement grout. Each riser pipe has a diffuser cap located on the sea floor and contains eight diffuser ports. The diffuser ports range in size from 0.492 to 0.644-feet in diameter (5.90 to 7.73-inches). Each diffuser port is tapered from the inside to the mouth of the port. A precast concrete cap and stone riprap protect all diffuser ports. The diffuser port caps are top be retained, cleaned and stored following the start-up of Outfall TO1. Details of the outfall tunnel and diffusers are located in Appendix B. (To see a hard copy of Appendix B, please call the MWRA Environmental Quality Department at 617-788-4700.)

4.2 SHUTDOWN SCENARIOS

Based on the information available and the analysis performed during the design and subsequent studies made for the startup of the Outfall TO1, the following shutdown scenarios have been developed.

- Short-term Shutdowns

- Long -term Shutdowns

Short -Term Shutdown

Once the ocean outfall has ceased its flow, the intrusion of seawater creates a potential for the fouling of the diffuser riser pipes, ports and eventually the outfall tunnel itself by microorganisms and other marine growth. The likelihood and extent of biofouling are based on seasonal considerations and on oxygen levels within the tunnel/riser system. Therefore, a short-term shutdown scenario was developed based on the effects of seawater intrusion and on minimizing the potential for fouling of the tunnel system. If it has been determined that the potential for biofouling has reached a point that it would be detrimental to the maintenance of the tunnel system, then a long term shutdown would be implemented. This decision would be based on the monitoring of the site for biofouling.

The duration of the short-term shutdown will be dependent on the amount of seawater inflow and the resultant potential growth of marine organisms. The process for the short-term shutdown is to divert the flow from the ocean outfall to the inner harbor outfalls as described in Section 2. This diversion will result in stagnant conditions in the Outfall TO1 tunnel and riser system. Under these conditions seawater, which has a higher specific gravity than that of the freshwater effluent, will flow down the risers and into the tunnel displacing the effluent. Any growth of marine organisms in the diffuser system would likely take more than 30 days to occur. The potential for development of marine growth is dependent on the extent of seawater intrusion and exchange as well as on seasonal variations in the nutrients, dissolved oxygen concentrations, temperature, and on the presence of colonizing life stages of certain marine organisms in the seawater. Examples of potential biofouling populations of concern are subtidal species of barnacles and blue mussels, which tend to form encrusting colonies on hard substrates. PB’s review of the riser videotapes, showing the condition of the risers from 1992 to the spring of 1999, suggests that neither barnacles nor blue mussels have become established on the nozzle caps.

A 30-day period has been set as a threshold for short-term shutdown during the most biologically active time of the year in Massachusetts Bay, typically from April to October. Should the shutdown occur after October, then the short-term shutdown scenario could be extended until the end of March with no additional measures taken.

After the 30-day threshold has been passed during a short-term shutdown, a monitoring program would be instituted. The monitoring program would investigate the presence of marine organisms on the diffusers that could potentially reduce the Outfall TO1's capacity. This program would be performed, on a periodic basis, by a dive team conducting visual observations at a representative number of risers. The investigations could also be performed by using a remotely operated vehicle. Laboratory analyses of growth on benthic sampling discs would also be used to determine the potential for biofouling. Based on the monitoring results, the decision to perform the long term capping of the diffusers will be made and the appropriate measures instituted.

Long -Term Shutdown

The long-term shutdowns would be for an indeterminate period of time, which is at a minimum, longer than 30 days. A decision by the MWRA to cap the diffusers could follow a few scenarios:

- Immediate capping of the diffuser ports with effluent discharge
- Immediate capping of the diffuser ports with no effluent discharge
- Capping of the diffuser ports with no effluent discharge following a short term shutdown and subsequent monitoring program

Capping of the diffuser ports while effluent is being discharged would be an option to be performed at the MWRA's discretion. The advantage of this method is that marine organisms would have little opportunity to enter the outfall pipe and diffuser systems. However this method is complex and requires the assistance of divers to re-install the caps. During some parts of the year it may not be possible to have a dive team working on the outfall due to weather conditions. During those times this option may not be available.

Capping of the diffuser ports with no effluent discharge would be done if the closure was an extension of the short-term shut-down or if it is not possible to have a dive team on hand due to bad weather at the required time of shut-down.

There are a total of 440 diffuser port caps, with eight located on each of the 55 diffusers. Each diffuser is equipped with four types of port caps at the time of initial startup: one with a pressure relief valve for air release during the charging of the system; one with a pressure gage for monitoring the pressure rise during tunnel construction, indicating a leak in the riser seals; one with a 5/16-inch hole drilled in it for backup air release purposes; and the remaining five ports with solid caps. The exception to this are the port caps for Diffuser No. 1, at the extreme eastern point of the tunnel, which consist of three pressure relief valves, one pressure gage, one cap with a 5/16-inch hole drilled in it, and three solid caps.

The modifications to the port caps depend upon the anticipated method of capping the diffuser ports. The modification of the diffuser caps for the long-term shut down will consist of the addition of a 4-inch equivolume valve to facilitate the installation of the cap under pressure and to allow for the long-term injection of chlorine as required. The valve will be capped with a special cap and quick-disconnect hose connection to allow for water sampling or the periodic injection of chlorine, if required.

If the diffuser port caps were to be re-installed after a period of shut down, then it would not be necessary to modify all of the caps. The existing diffuser port caps with the air release valves and the divers gage will be removed during the initial startup. Both of these types of diffuser port caps could be modified by removing the existing mounting cups with the air release valve and divers gage and then fabricating new mounting cups that would include a valve. This valve could be fitted with a quick connect fitting that would permit the removal of water for testing or for the injection of chlorine, if required. The diffuser port caps with the 5/16-inch diameter hole could be sealed by installing a nut and bolt through the hole with sealing washers at each end. These measures would provide for the outfall to be shut down while providing hydraulic access to the diffuser, if required.

All of the diffuser port caps would have a new O-ring gasket installed in the gasket groove. This is necessary since the existing gasket will have lost its ability to seal, and the reinstallation of the caps will require a gasket that will allow for the easy compression of the gasket for the underwater installation. The material chosen for the gasket is swelling polyurethane, a single component material that will swell to 300-percent after 72 hours of submersion in water. This gasket material will greatly reduce the time required to install the caps on the diffuser ports. Details of the diffuser port cap modifications are located in Appendix B. (To see a hard copy of Appendix B, please call the MWRA Environmental Quality Department at 617-788-4700.)

4.3 INSTALLATION OF DIFFUSER PORT CAPS

The diffuser ports would be sealed by installing caps in order to protect the interior components of the diffuser, the risers, and the tunnel. The following outlines the procedures to be followed when sealing the diffuser ports both with and without effluent discharge. If it is anticipated that the outfall could be subsequently dewatered, then one cap with an air release valve must be provided on each of the risers with three air release valves being installed on Riser No. 1. The following typical procedures assumes that an air release valve will be required on each riser:

Sealing of Diffuser Ports with Effluent Discharge

The sealing of the diffuser ports during effluent discharge would be performed in the following sequence:

- Start at Diffuser No. 55, at the nearshore end, and proceed to the offshore end of the outfall tunnel, at Diffuser No.1.
- Clean each diffuser port of any loose debris and marine growth.
- Install one diffuser port cap with the air release valve on each riser assembly.
- Remove the 4-inch pipe cap and quick disconnect valve; open the equivolume valve.
- Place each diffuser valve over the diffuser port and allow the flow to pass through the open valve.

- Twist the cap until it seats and locks into position.
- After all of the diffuser port caps are in place on each diffuser, close all of the equivolume valves and install the pipe cap and quick disconnect hose connection.
- Proceed to the next diffuser in an easterly direction repeating the same procedure at each diffuser to the eastern limit of the diffuser field.

Note: As the diffusers are capped the flow in the outfall must be closely controlled, by balancing the flow from the outfall to the inner harbor outfalls as described in Section 2. This flow is to be controlled to reduce pressure at the existing open diffuser ports to allow for placement of caps on the diffuser ports. The suggested method of controlling the flow is to reduce the inflow to the outfall in increments to be determined as the diffuser ports are sealed and closed. It is anticipated that a flow reduction in increments of 10% would facilitate cap installation. By using the caps with the open valves, the diffuser port capping process can be undertaken during normal Deer Island flow rates. The number of dive teams required to close the diffuser ports in this manner depends upon the needed speed to cap the nozzles. If a period of potential bad weather is forcast then additional dive teams may be needed. Several dive teams will be necessary should it become necessary to shut the outfall down quickly as a result of some environmental event.

Sealing of the Diffuser Ports with No Effluent Discharge

The sealing of the diffuser ports with no effluent discharge would be performed in the following sequence:

- Start at Diffuser No. 55, at the nearshore end, and proceed to the offshore end of the outfall tunnel, at Diffuser No.1.
- Clean each diffuser port of any loose debris and marine growth.
- Install one modified diffuser port cap with a valve and an air release valve on each riser assembly.
- Install the other modified port cap with a valve in the closed position and quick disconnect connection/cap in place.
- Install the remaining diffuser port caps comprised of blank port caps and the port cap sealed by the 5/16th bolt and washer at that riser.
- Proceed to the next riser in an easterly direction, using the same procedure at each riser as was used at Riser No. 55, finishing at Riser No. 1.

4.4 LONG TERM MAINTENANCE OF SEALED DIFFUSER PORTS

The sealed diffuser ports would be inspected over the period of the sealed shutdown. This is accomplished by the use of divers who would inspect the caps and diffusers on a regular schedule. It is anticipated that the inspections would be on a yearly schedule, unless some event would require more frequent monitoring.

Depending on the length of time the ocean outfall is shut down, it may be required that periodic injections of chlorine be performed to minimize any maintenance of the tunnel system due to biogrowth. The determination of the quantity and frequency of any injection and remedial work for maintenance would be performed by the Authority.

4.5 RECOMMENDATIONS

This section summarizes PB's recommendations for the shutdown and preservation of Outfall TO1. First it is recommended that once the diffuser caps have been removed in conjunction with the start-up activities of Outfall TO1 that the caps be retained, cleaned and stored for future use. Additionally, it is recommended that the cap modification required for installation under no flow conditions be performed before the caps are placed into storage. Modifying the caps ahead of time will minimize the time required to cap the diffusers if needed.

Due to the level of effort, complexity, and environmental impact to the harbor described in Sections 1, 2 and 4, Outfall TO1 should only be shut down after careful consideration of the circumstances. Figure 4-1 outlines the recommended approach for preserving Outfall TO1 during short term and long term shutdowns.

If the outfall is shut down for a short period, then the implementation of a monitoring program is recommended to determine if biofouling could interfere with the successful subsequent startup

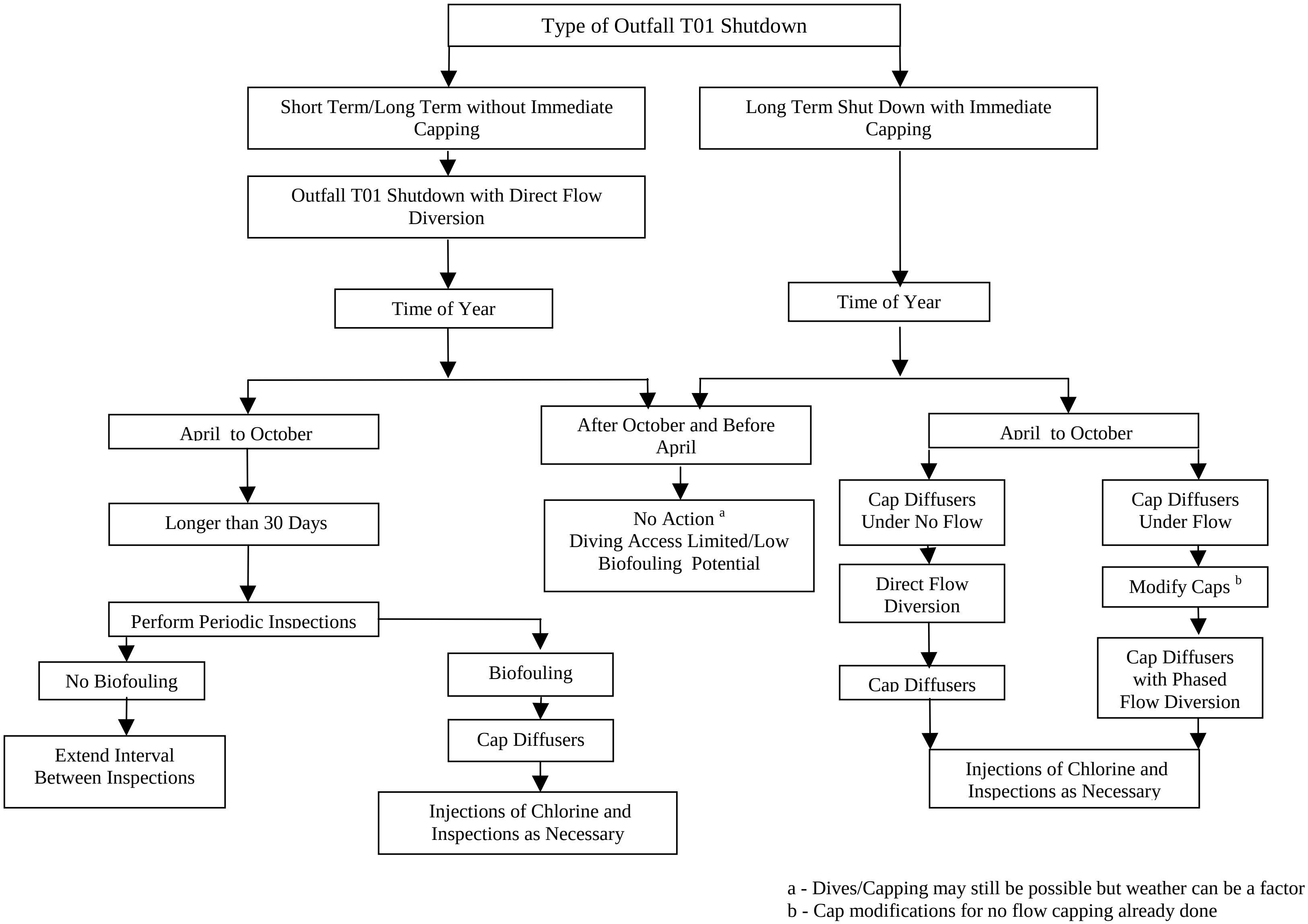


Figure 4-1: Recommended Approach for Preserving Outfall T01 During Shutdown(s)

and operation of the outfall. If this monitoring program identifies a significant potential for biofouling of the system (an average 10-percent blockage of diffuser ports) then cleaning followed by capping of the diffuser ports is recommended. Diffuser port capping would provide a positive means to keep chlorinated fresh water in the tunnel and preclude nuisance species of barnacles and mussels from entering the outfall. Diffuser port capping, after a monitoring program, would be implemented under a no flow condition due to the fact that the flow has already been diverted. In addition, if the monitoring program identifies a significant potential for biofouling of the system, which would necessitate diffuser port capping, then it is recommended that future shutdowns consider immediate capping of the diffusers to minimize this potential.

If diffuser port capping is to be implemented immediately as in the case of a shutdown with a known long duration, then direct flow diversion is recommended followed by capping of the diffusers under a no flow condition. Diffuser port capping under effluent discharge conditions is not recommended due to the difficulty and complexity of cap modification, close coordination of diving operations and plant operations required, and length of time required to complete the diffuser port capping under flow. Table 4.1 summarizes the advantages and disadvantage of capping the diffusers under effluent flow and no flow conditions.

Table 4.1: Diffuser port capping Under Discharge and No Discharge Conditions

Capping Scenario	Advantages	Disadvantages
Diffuser port capping Under Effluent Discharge Conditions	- Minimal seawater intrusion - Minimal biofouling potential - Reduced cleaning requirement upon restarting of Outfall TO1	- Long duration to cap - Larger cost/duration for cap modification - Higher cost of installation - Large coordination effort required with plant operations
Diffuser port capping Under No Effluent Discharge Conditions	- Shorter duration to cap - Smaller cost/duration for cap modification - Lower installation cost (half as much) - Independent of plant operations required	- Some seawater intrusion - Biofouling potential dependent on season and saltwater exchange - Increased cleaning requirement dependent on amount of biofouling