Technical Memorandum

To: Mr. Patrick Crain, Poseidon

From: Greg Allen and George Hecker, Alden

Date: April 26, 2017

Re: **Addendum to Supplement March 22, 2017 Technical Memorandum "Summary of Head Loss Calculations for the Poseidon Huntington Beach Desalination Plant Discharge System" and March 31, 2017 Technical Memorandum "Diffuser Head for Co-located and Stand-alone Operation of the Poseidon Huntington Beach Desalination Plant"**

Alden Research Laboratory, Inc. (Alden) has performed additional analyses to supplement previous head loss evaluations of Poseidon Water Surfside's (Poseidon) Huntington Beach Desalination Plant's (HBDP) discharge system. The HBDP is to be constructed at the site of the existing Huntington Beach Generating Station (HBGS) and will use some of the existing HBGS cooling water system infrastructure. This Technical Memorandum (TM) provides additional information on the onshore portion of the discharge system for a flow of 254 MGD and supplements Alden's previous TMs dated March 22 and March 31, 2017, which described the process used in developing the conceptual design for the diffuser and the total calculated head loss (onshore and offshore components of the discharge line) for the maximum flow in the discharge line when the HBDP is in operation (127 MGD).

Under the 254 MGD scenario (described in this TM), there would be no flow from the HBDP – only flow associated with the cooling water circuit of the HBGS. Table 1 in this TM presents the results of the head loss calculations for the 254 MGD scenario and compares the results for the 127 MGD scenario that was presented in the March 22, 2017 TM. As was described in the previous Alden TMs, the 254 MGD scenario would occur prior to the operation of the HBDP, and this 254 MGD scenario was only evaluated to determine if the diffuser could be installed prior to the decommissioning of one of the two remaining power generating units at the HBGS. The previous Alden TM determined that a diffuser could be installed to accommodate a flow of 254 MGD from the HBGS. As this scenario would occur prior to the operation of the HBDP (and prior to the introduction of brine into the discharge line), Alden determined that a 4.5 ft opening in the top of the diffuser would create a head loss approximately equal to the scenario of maximum design flow through the discharge piping with the HBDP in operation (127 MGD with all of the discharge flow directed through the three "duck-bill" type check valves with the 4.5 ft opening on top of the diffuser closed).

As is shown in Table 1, the total head loss (on-shore and off-shore portion) for the discharge line is 4.99 ft for the 127 MGD scenario (center opening closed) compared to 4.87 ft for the 254 MGD scenario with the center 4.5 ft diameter opening open. Although the head loss for the 254 MGD scenario is less than the head loss for the 127 MGD scenario, we have also provided additional calculations for your consideration that show that the head loss can be further reduced by using a 4.5 ft square opening on the top of the diffuser instead of a round opening. A 4.5 ft. square opening would reduce the total head loss to 4.28 ft.

In summary, the TMs demonstrate that the diffuser described in Alden's conceptual design can accommodate a flow of 254 MGD with the center port open and a flow of 127 MGD with the center port closed, and that both scenarios result in approximately the same head loss in the existing discharge line (onshore and offshore portions). In addition, the calculations show that there are further refinements that could be evaluated in the detail design phase that would further reduce the total head loss in the discharge line for the 254 MGD scenario such as modifying the geometry of the discharge opening.

Table 1. HBGS Discharge System Calculated Head Losses

Description	Head Loss (ft)			Notes
	Desal Only Operation 127 MGD	HBGS Only Operation 4.5 ft dia. open port 254 MGD	HBGS Only Operation 4.5 ft sq. open port 254 MGD	
station 1 - 2	0.71	0.00	0.00	Losses only attributed to desal operation at tie in point.
Station 2 - 3	0.15	0.15	0.15	
Station 3 - 4	0.10	0.10	0.10	
	0.01	0.01	0.01	
Station 4 - 5	0.00	0.00	0.00	
Station 5 - 6	0.01	0.01	0.01	
Station 6 - 7	0.00	0.00	0.00	
Station 7 - 8	0.02	0.02	0.02	
Station 8 - 9	0.01	0.01	0.01	
	0.05	0.05	0.05	
Station 9 - 10	0.06	0.06	0.06	
Station 10 - 11	0.09	0.11	0.11	crossover junction from west to east channel
Station 11 - 12	0.00	0.00	0.00	
Station 12 - 13	0.01	0.03	0.03	
Station 13 - 14	0.01	0.03	0.03	
Station 14 - 15	0.00	0.01	0.01	Transition to offshore 14 ft dia. pipe
Station 11 - 15	0.00	0.02	0.02	
Onshore subtotal	**1.23**	**0.60**	**0.60**	
Station 15 - 16	0.18	0.73	0.73	Offshore pipe 2130 ft
Station 16 - 17	0.02	0.07	0.07	tower and manifold
Station 17 - ocean	3.56	3.47	2.88	Duck bill diffuser valves (3, 36" valves by Tideflex) and 4.5 ft port losses. Port open for 254 MGD HBGS Only Operation
Offshore subtotal	**3.76**	**4.27**	**3.68**	
Total	**4.99**	**4.87**	**4.28**	

Memorandum

12 April 2017

To:	Patrick Crain, Poseidon Water	Ref. No.:	11110796
From:	Paul Hermann, Eduardo Pinzon	Tel:	949-585-5200
CC:			
Subject:	HBDP Outfall Summary		

1. Introduction

Following a call on Thursday March 30, 2017 with the California State Lands Commission (CSLC), Poseidon Water, GHD and Alden Research Laboratories (Alden), GHD understands that there was a follow up call between the CSLC and Poseidon on April 6, 2017. The April 6, 2017 called resulted in additional questions on the proposed desalination project in Huntington Beach (HBDP) on the evaluation of the estimated head loss in the existing discharge system prior to and after the start of operations of the HBDP. Specifically, CSLC requested the following:

- Confirmation that the head loss estimates included both the offshore and the onshore components of the discharge system.
- A discussion on scenarios involving flows higher than 127 MGD which is the maximum flow that will occur when the HBDP is brought into service.
- Scope division and coordination between Alden and GHD; specifically whether the joint head loss evaluation studies conducted by both parties were sufficient to determine that the proposed modifications will not impact the existing discharge system.

2. GHD's Project Role

For the HBDP project, GHD acts as the Owner's Engineer to Poseidon and provides technical assistance at all stages of the project. This is similar to the role GHD played for Poseidon on the Carlsbad Desalination Plant in which the following services were provided:

- Engineering assistance for permitting,
- Design review,
- Construction supervision,
- Technical support during commissioning; and

- Technical support related to operations/maintenance.

Regarding the head loss evaluation for the HBDP, Poseidon requested that GHD advise on how to evaluate the suitability of the discharge facilities in the permitting phase prior to performing a physical inspection of the discharge system. Subsequently, Poseidon has stated that the subject inspection would be performed by their selected contractor once the permits are issued and the detailed design is initiated." GHD recommended the following:

1. Retrieve and review existing inspection reports on the discharge system that have been performed by the operator of the power generating station.
2. Calculate the estimated head loss in the existing discharge system as it is currently configured, i.e. with no diffuser; before the HBDP brine discharge is connected. GHD recommended that the original design conditions be estimated by considering the maximum design flow for all four power generating units as well as the estimated head loss for the existing plant configuration (two power generating units operational and two power generating units operating in a synchronized condenser mode.) This equates to flows of 514 MGD and 387 MGD respectively.
3. Evaluate the estimated head loss in the discharge system after a diffuser is added to the discharge line. The head loss estimate should include the entire discharge system - offshore components and the onshore components up to the location where the brine from the HBDP would be introduced into the discharge system. The maximum flow for this scenario is 127 MGD.
4. Compare and provide final conclusions in relation to the estimated head loss in the discharge system for both the original design parameters and the current configuration to the estimated head loss in the discharge system after the installation of the diffuser at a flow of 127 MGD.

   The intent of this item is to determine from the above stated analysis whether the proposed system with the addition of the diffuser and reduced flows would cause greater stress on the discharge system beyond what the system was designed to handle, its current capability, or otherwise.

3. Findings Summary

Below is a summary of the finding:

1. Poseidon provided inspection reports from the operator of the power generating station which included written reports. GHD reviewed the reports and could not identify any significant deficiencies in the existing discharge system.
2. GHD evaluated the head loss in the discharge system for the current conditions – 254 MGD from power generating units 1 and 2 and 133 MGD from power generating units 3 and 4 which are now operated under a synchronized condenser mode, in addition to the original design condition (514 MGD). In performing the calculations, GHD considered the current condition of the pipe, in addition to performing a sensitivity analysis using an increased friction factor coefficient assuming a worse than expected pipe condition as a result of marine growth and pipe aging. This information was detailed in a GHD Technical Memorandum to Poseidon dated March 20, 2017. As described in the Technical Memorandum, the expected design head loss for the discharge system would have

ranged from approximately 5.46 ft. to 5.83 ft. depending on what assumptions the original designers made for roughness coefficient in the discharge system after some duration of plant operation. Further, GHD calculated the head loss that the discharge system is experiencing now at its current peak operation flow ranges from approximately 4.88 ft to 5.12 ft.

3. For estimating the head loss after the addition of the diffuser, Poseidon elected to utilize Alden to develop a conceptual design for the diffuser. Alden, which specializes in applied fluid dynamic consulting, has the necessary expertise to evaluate various diffuser options to meet performance requirements while minimizing head loss. Alden's direction was to develop a diffuser capable of performing over the full range of flows that would be expected during the operation of the HBDP, 25 MGD to 127 MGD. Another flow scenario analyzed is for the maximum flow that could be expected in 2019, 254 MGD (after the synchronized condenser mode of operation is permanently discontinued but before the first of the two power generating units is permanently decommissioned.) While the HBDP would never operate in this interim period (254 MGD flow through the discharge system) when the HBGS has two power generating units available to produce power, Alden evaluated this scenario in the diffuser conceptual design. If the diffuser were designed to handle both the 127 MGD and the 254 MGD flows, the diffuser installation could be scheduled in 2019 (well before the start of HBDP operation.) This option would allow Poseidon to de-link this critical task in the desalination plant's construction schedule from the HBGS's decommissioning schedule resulting in cost and schedule savings to Poseidon.

   Alden determined that by introducing a center port (4.5 ft. diameter) into the diffuser, the head loss in the discharge system with both power generating units in operation (254 MGD) would be similar (negligible head loss difference) as the scenario when the center port is closed for the 127 MGD scenario (maximum design flow with the HBDP is in operation).

At this stage of the design development, the results of Alden's study are sufficient to conclude that the diffuser concept proposed for the discharge system for the HBDP could be installed prior to the start of operations of the HBDP without any appreciable change in the backpressure in the discharge system. This was detailed in Alden's Technical Memorandum dated March 31, 2017. No further backpressure evaluations are necessary as the 254 MGD flow scenario would never occur when the HBDP is in operation and because in terms of back pressure, 254 MGD with the port open is equivalent to 127 MGD with the port closed.

GHD then advised Poseidon to request that Alden calculate the head loss for the entire discharge system from the offshore diffuser to the location where the HBDP would introduce the brine into the existing system for the maximum design flow of 127 MGD. As was detailed in Alden's Technical Memorandum dated March 22, 2017, Alden calculated the head loss from the offshore diffuser to the location assumed for the connection point of the brine discharge to the existing discharge system. Using the available as-built drawings, Alden calculated the head loss from the connection point to the offshore diffuser to range from 4.09 ft. to 4.99 ft. Alden noted that improving the geometry at the connection point and splitting the flow between the parallel 108 - inch diameter lines would help reduce head loss – options that would be evaluated during the detained design phase. The head loss information was also required to begin the preliminary design of the gravity flow brine line from the HBDP to the existing discharge system.

4. Conclusion

After the results of the Alden study were available, GHD compared the expected head loss in the discharge system with the HBDP in operation compared to the expected original design parameters and the current operating conditions of the discharge system. Based on the analysis performed by both GHD and Alden, GHD believes that Poseidon can reasonably assume that the proposed duty for the discharge system during HBDP operation is within the system's capabilities based on its anticipated operation under normal operating conditions.

Technical Memorandum

To: Mr. Patrick Crain and Ms. Josie McKinely, Poseidon

From: George Hecker and Greg Allen, Alden

Date: March 31, 2017

Re: **Diffuser Head for Co-located and Stand-alone Operation of the Poseidon Huntington Beach Desalination Plant**

At the request of Poseidon Water (Poseidon), Alden Research Laboratory, Inc. (Alden) developed a conceptual design for an offshore brine discharge diffuser for the proposed Huntington Beach Desalination Plant (HBDP). Poseidon requested that the design accommodate the normal range of flows that would be discharged through the diffuser including the maximum flow of 127 MGD. Poseidon also asked Alden to evaluate if the design could incorporate the ability to handle a flow of 254 MGD which could occur when two power generating units from the Huntington Beach Generating Station (HBGS) are in operation. According to Poseidon, the decommissioning date of power generating units at the HBGS has not been finalized and Poseidon would like the capability of installing the diffuser prior to the permanent decommissioning of the two power generating units without impacting the HBGS operations. Poseidon also stated it would not be operating the HBDP until after one of the HBGS power generating units is permanently decommissioned.

In order to meet the design requirements requested by Poseidon, Alden developed a diffuser design incorporating three flexible "duck-bill" type check valves and a single port on the top of the diffuser. During the phase prior to the start of the HBDP, the single port would be open. After the HBGS permanently decommissions one of the power generating units, the flow in the discharge system would be reduced to a maximum of 127 MGD which would allow the single port to be permanently closed. In developing the design of the diffuser, Alden optimized the size of the single port so that the back pressure in the discharge system at a flow of 254 MGD with the port open would approximate the back pressure in the system for a flow of 127 MGD with the port closed.

This memorandum provides a summary of the back pressure performance for the proposed offshore diffuser design for various discharge flow conditions for the scenario with the port open (prior to the decommissioning the power generating units) and with the port closed (after the decommissioning the power generating units). The proposed diffuser is presented in Figure 2 and consists of a capped discharge tower with three 36- inch Tideflex discharge check valves.

A 4.5 ft. diameter port is located in the center of the capped discharge tower. The port would be closed after at least one of the power generating units is decommissioned (i.e. flows through the discharge system would be less than 127 MGD). The performance of the diffuser with and without the center port open is shown on Figure 1 and Table 1. The total head on shore represents the head loss of the discharge system from the start of the 14 ft diameter discharge pipe on shore to the duck-bill diffuser offshore.

Table 1. Head at upstream tunnel entrance with and without 4.5 ft diameter center port open (three 36 inch duck bill check valves on diffuser cap)

Closed Center Port		With Open 4.5 ft Center Port	
Flow (MGD)	Total head Onshore (ft)	Flow (MGD)	Total head Onshore (ft)
127.0	3.7	386	6.9
116.5	3.4	260	4.0
73.0	2.1	156	1.9
62.5	1.8	115	1.2
40.0	1.1	84	0.7
25.0	0.7	54	0.4

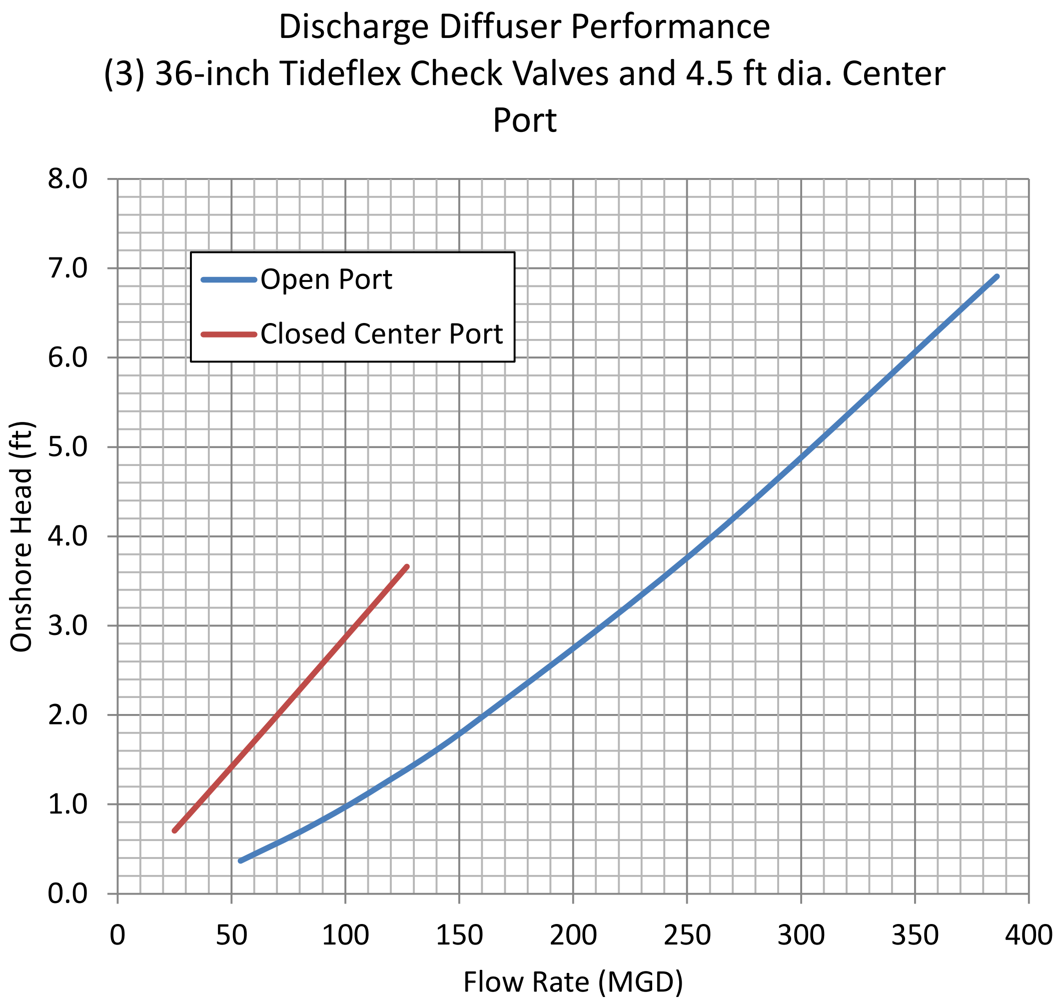

Figure 1. Head at tunnel entrance on shore versus flow for discharge diffuser with and without 4.5 ft diameter center port.

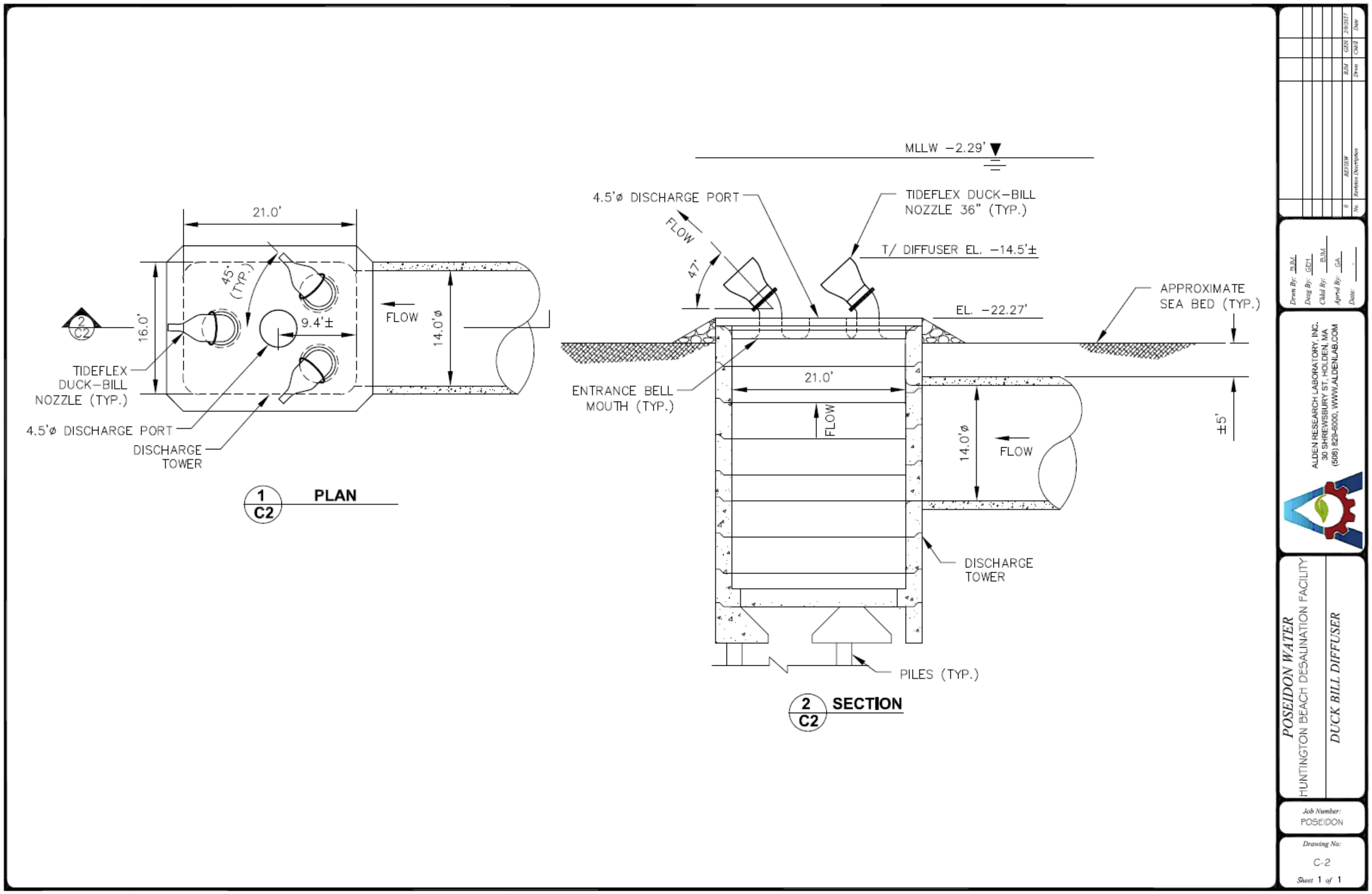

Figure 2. Proposed diffuser design with three 36-inch duck-bill valves and a 4.5 ft dia. port.

Memorandum

20 March 2017

To	Patrick Crain, Poseidon Water		
Copy to	GHD		
From	Paul Hermann, Eduardo Pinzon	Tel	949 250 0501
Subject	Huntington Beach Outfall – Head Loss Review	Job no.	11110796

1 Criteria

To purpose of this TM is to advise of the head loss in the existing outfall pipeline configuration, under the following conditions:

1. Original / design operating condition of:
   - 257 MGD in the 108" diameter pipe (maximum discharge flow from Units 1 & 2; noting that another 108" diameter pipe exists to handle the maximum discharge flow from of 254 MGD from Units 3 & 4); and
   - 514 MGD in the single 14' diameter outfall pipe
2. Current / existing operating condition of:
   - 257 MGD in the 108" diameter pipe (maximum discharge flow from Units 1 & 2; noting that another 108" diameter pipes exists to handle 130 MGD for Units 3 & 4 under a condition when the synchronized condenser is operational); and
   - 387 MGD in the single 14' diameter outfall pipe

2 Roughness Factors

GHD used Hazen Williams to determine the friction losses in the system. Roughness coefficients used were 120 from the connection point on the upstream end of the 108" diameter pipe, to the commencement of the 14" diameter outfall pipe, and 130 for the 14" diameter outfall pipe.

A sensitivity check on the system was also undertaken using a roughness coefficient of 110. The variability in roughness coefficients here is based on the unknowns surrounding the extent of marine growth, with the sensitivity analysis providing some guidance as to the potential impacts.

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3 Results

The results are as follows:

Operating Condition	Hazen Williams roughness coefficient 120 & 130	Hazen Williams roughness coefficient 110
Original / design	~ 5.46 ft	~ 5.83 ft
Current / existing	~ 4.88 ft	~ 5.12 ft

4 Conclusions

The head loss apparent in the system is a conservative approximation based on the as-built information interpretation during the analysis, and assumed pipe roughness coefficient.

Key conclusions from the above include:

- The reduction in flow, albeit minor, has a considerable effect on reducing the head loss in the system
- The increasing of the roughness coefficient appears to have less impact on the head loss in the system, especially when the flows are reduced.

Noting the above, with the removal of the power station operation, the reduction in flow from the design condition the outfall was constructed to, and the future operation which will convey desalination brine discharge only, the pressure on the outfall system is expected to be considerably less.

EXISTING CONDITION ANALYSIS

DESCRIPTION		ID	ID	Area	Length	Q	Q	V	HW	K	H_L
		in	ft	SF	ft	mgd	CFS	fps	Coeff	Minor Loss	ft
108" RCP Circulating Pipe		108.0	9.00	63.62	280.0	257	397.64	6.25	110		0.321
22.5 bend		108.0	9.00	63.62		257	397.64	6.25		0.300	0.182
Pipe Inside Intake Screenwell Structure		108.0	9.00	63.62	22.0	257	397.64	6.25	110		0.025
Sudden Expansion 9' to 11'-7"	D1 =	108.0	9.00	63.62							
	D2 =	139.0	11.58	105.38		257	397.64	3.77		0.157	0.035
Pipe Inside Intake Screenwell Structure		139.0	11.58	105.38	15.0	257	397.64	3.77	110		0.005
45 bend		139.0	11.58	105.38		257	397.64	3.77		0.450	0.099
Pipe Inside Intake Screenwell Structure		139.0	11.58	105.38	20.0	257	397.64	3.77	110		0.007
90 bend				36.43		257	397.64	10.92		0.900	1.665
Pipe under	h1 = 14.0	ft	6.81	36.43	30.0	257	397.64	10.91	110		0.134
Intake	h2 = 4.5	ft	Equivalent								
90 bend				36.43		257	397.64	10.92		0.900	1.665
Sudden Expansion 4.5' to 14'	D1 =	54.0	4.50	15.90							
	D2 =	168.0	14.00	153.94		387	598.78	3.89		0.804	0.189
Junction Structure		168.0	14.00	153.94		387	598.78	3.89		0.600	0.141
14' Discharge Pipe		168.0	14.00	153.94	2300.0	387	598.78	3.89	110		0.654
							Sub-Total Head Loss			Σ =	5.122
							Total Head Loss			**Σ =**	**5.122**

EXISTING CONDITION ANALYSIS

DESCRIPTION	ID in	ID ft	Area SF	Length ft	Q mgd	Q CFS	V fps	HW Coeff	K Minor Loss	H_L ft
108" RCP Circulating Pipe	108.0	9.00	63.62	280.0	257	397.64	6.25	110		0.321
22.5 bend	108.0	9.00	63.62		257	397.64	6.25		0.300	0.182
Pipe Inside Intake Screenwell Structure	108.0	9.00	63.62	22.0	257	397.64	6.25	110		0.025
Sudden Expansion 9' to 11'-7" D1 =	108.0	9.00	63.62							
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Pipe Inside Intake Screenwell Structure	139.0	11.58	105.38	20.0	257	397.64	3.77	110		0.007
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Sudden Expansion 4.5' to 14' D1 =	54.0	4.50	15.90							
D2 =	168.0	14.00	153.94		514	795.28	5.17		0.804	0.333
Junction Structure	168.0	14.00	153.94		514	795.28	5.17		0.600	0.249
14' Discharge Pipe	168.0	14.00	153.94	2300.0	514	795.28	5.17	110		1.106
						Sub-Total Head Loss			Σ =	5.826
						Total Head Loss			**Σ =**	**5.826**

EXISTING CONDITION ANALYSIS

DESCRIPTION	ID in	ID ft	Area SF	Length ft	Q mgd	Q CFS	V fps	HW Coeff	K Minor Loss	H_L ft
108" RCP Circulating Pipe	108.0	9.00	63.62	280.0	257	397.64	6.25	120		0.273
22.5 bend	108.0	9.00	63.62		257	397.64	6.25		0.300	0.182
Pipe Inside Intake Screenwell Structure	108.0	9.00	63.62	22.0	257	397.64	6.25	120		0.021
Sudden Expansion 9' to 11'-7" D1 =	108.0	9.00	63.62							
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Pipe Inside Intake Screenwell Structure	139.0	11.58	105.38	15.0	257	397.64	3.77	120		0.004
45 bend	139.0	11.58	105.38		257	397.64	3.77		0.450	0.099
Pipe Inside Intake Screenwell Structure	139.0	11.58	105.38	20.0	257	397.64	3.77	120		0.006
90 bend			36.43		257	397.64	10.92		0.900	1.665
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Intake h2 = 4.5	ft	Equivalent								
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Junction Structure	168.0	14.00	153.94		514	795.28	5.17		0.600	0.249
14' Discharge Pipe	168.0	14.00	153.94	2300.0	514	795.28	5.17	130		0.812
						Sub-Total Head Loss			Σ =	5.459
						Total Head Loss			**Σ =**	**5.459**

EXISTING CONDITION ANALYSIS

DESCRIPTION	ID in	ID ft	Area SF	Length ft	Q mgd	Q CFS	V fps	HW Coeff	K Minor Loss	H_L ft
108" RCP Circulating Pipe	108.0	9.00	63.62	280.0	257	397.64	6.25	120		0.273
22.5 bend	108.0	9.00	63.62		257	397.64	6.25		0.300	0.182
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Junction Structure	168.0	14.00	153.94		387	598.78	3.89		0.600	0.141
14' Discharge Pipe	168.0	14.00	153.94	2300.0	387	598.78	3.89	130		0.480
						Sub-Total Head Loss			Σ =	4.875
						Total Head Loss			**Σ =**	**4.875**