3.0 Existing Submerged Offshore Intakes - Add Velocity Caps

Velocity caps are applicable to submerged offshore intakes. Adding velocity caps to facilities with existing or new submerged offshore intakes only provides impingement reduction. Therefore, this module may be most applicable when the compliance option only requires impingement controls and the intake requires upgrading. However depending on site-specific conditions, velocity caps could conceivably be used in conjunction with onshore screening systems tailored for entrainment improvement.

Research on velocity cap vendors identified only one vendor located in Canada. (A possible reason for this scarcity in vendors is that many velocity caps are designed and fabricated on a site-specific basis.) This vendor manufactures a velocity cap called the "Invisihead," and was contacted for cost information (Elarbash 2002a and 2002b). The Invisihead is designed with a final entrance velocity of 0.3 fps and has a curved cross-section that gradually increases the velocity as water is drawn farther into the head. The manufacturer states the gradual increase in velocity though the velocity cap minimizes entrainment of sediment and suspended matter and minimizes inlet pressure losses (Elmosa 2002). All costs presented below are in July 2002 dollars.

Capital Costs

The vendor provided information for estimating retrofit costs for velocity caps manufactured both from carbon steel and from stainless steel. Stainless steel construction is recommended for saltwater conditions to minimize corrosion. Carbon steel is recommended for freshwater systems. Due to the rather large opening, Invisihead performance is not affected by the attachment of Zebra mussels, so no special materials of construction are required where Zebra mussels are present.

Installation costs include the cost for a support vessel and divers to cut, weld and/or bolt the fitting flange for the velocity cap; make any needed minor reinforcements of the existing intake; and install the cap itself. Installation was said to take between two and seven days, depending on the size and number of heads in addition to the retrofit steps listed above. Costs also include mobilization and demobilization of the installation personnel, barge, and crane. The vendor indicated these costs included engineering and contractor overhead and profit, but did not provide break-outs or percentages for these cost components. The estimated capital costs do not yet include contingency costs, which will be incorporated separately. EPA has concluded that the installation costs for adding a velocity cap on a new intake (relocated offshore) and on an existing offshore intake should be similar because most of the costs involve similar personnel and equipment. (See the "Application" section below for a discussion of new/existing submerged offshore intake cost components.)

Table 3-1 presents the component (material, installation, and mobilization/demobilization) and total capital costs for stainless steel and carbon steel velocity caps provided by the vendor (Elarbash 2002a and 2002b) . Data are presented for flows ranging from 5,000 gpm to 350,000 gpm. Figure 3-1 presents a plot of these data. The upper end of this flow range covers existing submerged pipes up

to 15 feet in diameter at pipe velocities of approximately 5 fps. Second-order polynomial equations provided the best fit to the data and were used to produce cost curves. These cost curves serve as the basis for estimating capital costs for installing velocity caps on existing or new intakes submerged offshore at Phase II facilities. When applying these cost curves, if the intake flow exceeds 350,000 gpm plus 10% (385,000 gpm), the flow is divided into equal increments and these lower flows costed. The costs for these individual incremental flows are summed to estimate total capital cost. In these cases, costs are assumed to be applied to multiple intake pipes. If the intake flow is less than 5,000 gpm, the capital cost for 5,000 gpm will be used rather than extrapolating beyond the bottom end of the cost curve.

O&M Costs

For velocity caps, O&M costs generally include routine inspection and cleaning of the intake head. As noted above, biofouling does not affect velocity cap performance, so rigorous cleaning is not necessary. The vendor stated that their equipment is relatively maintenance free. However, O&M costs based on an annual inspection and cleaning of offshore intakes by divers were cited by facilities with existing offshore intakes, including some with velocity caps and especially those with bar racks at the intake. Therefore, estimated O&M costs are presented for an annual inspection and cleaning by divers because EPA believes this is common practice for submerged offshore intakes of all types.

Table 3-2 presents the component and total O&M costs for the diver inspection and cleaning, for one to four days (Paroby 1999). In general, O&M costs are based on less than one day per head for inspection and cleaning of smaller intake heads and one day per head for the largest intake head. There is a minimum of one day for each inspection event. Inspection and cleaning events are assumed to occur once per year. Figure 3-2 presents the plot of the O&M costs by flow. A second-order polynomial equation provided the best fit to this data and serves as the basis for estimating the O&M costs.

Figure 3-2 also shows data for two facilities that reported actual O&M costs based on diver inspection and cleaning of submerged offshore intakes. While these two facilities use different intake technologies (passive screens for the smaller flow and bar rack type intakes for the larger flow), the inspection and cleaning effort should be similar for all three types of intakes. For both facilities, the actual reported O&M costs were less than the costs estimated using the cost curves, indicating that the estimated O&M costs should be considered as high-side estimates.

Application

As Retrofit of Existing Offshore Intake

Adding velocity caps to facilities with existing offshore intakes will provide impingement reduction only. For facilities withdrawing from saltwater/brackish waters (ocean and estuarine/tidal rivers), the capital cost curve for stainless steel caps will be applied. For the remaining facilities withdrawing freshwater (freshwater rivers/streams, reservoirs/lakes, Great Lakes), the capital cost curve for carbon steel caps will be applied. The same O&M cost curve will be used for both freshwater and saltwater systems. It is assumed that the existing intake is in a location that will provide sufficient clearance and is away from damaging wave action.

As Component of Relocating Existing Shoreline Intake to Submerged Offshore

These same velocity cap retrofit costs can be incorporated into retrofits where an existing shoreline intake is relocated to submerged offshore. In this application, some of the same equipment and personnel used in velocity cap installation may also be used to install other intake components, such as the pipe. Therefore, the mobilization/demobilization component could be reduced if these tasks are determined to occur close together in time. However, a high-side costing approach would be to cost each step separately, using the same velocity cap costs for both new and existing offshore intake pipes. In this case, the installation costs for velocity caps at existing offshore intakes (which include costs for cutting, and welding and/or bolting the velocity cap in place) are assumed to also cover costs of installing connection flanges at new offshore intakes. Costs for other components of relocating existing shoreline intakes to submerged offshore are developed as a separate cost module associated with passive screens. The compliance cost estimates did not include this scenario.

References

Elarbash, M. Elmosa Canada. email correspondence with John Sunda, SAIC concerning cost and technical data for Invisihead velocity caps. August 9, 2002a

Elarbash, M. Elmosa Canada. email correspondence with John Sunda, SAIC concerning cost and technical data for Invisihead velocity caps. August 19, 2002b

Elmosa. Website at http://www.imasar.com/elmosa/invisiheaddetails.htm accessed May 9, 2002.

Paroby, Rich. Personal communication between Rich Paroby, District Sales Manager, Water Process Group and Deborah Nagle, USEPA E-mail dated May 12, 1999.

Table 3-1

Velocity Cap Retrofit Capital and O&M Costs (2002 $)

Flow (gpm)	# Heads	Material Costs - Stainless Steel /Head	Material Costs - Stainless Steel Total	Material Costs - Carbon Steel /Head	Material Costs - Carbon Steel Total	Installation	Mobilization/ Demobilization	Total Capital Costs - Stainless Steel	Total Capital Costs - Carbon Steel	Total O&M
Water Type	All	Saltwater	Saltwater	Freshwater	Freshwater	All	All	Saltwater	Freshwater	All
5,000	1	$30,000	$30,000	$22,500	$22,500	$25,000	$10,000	$65,000	$57,500	$5,260
10,000	1	$30,000	$30,000	$22,500	$22,500	$30,000	$15,000	$75,000	$67,500	$5,260
25,000	1	$40,000	$40,000	$30,000	$30,000	$35,000	$15,000	$90,000	$80,000	$5,260
50,000	2	$35,000	$70,000	$26,250	$52,500	$49,000	$25,000	$144,000	$126,500	$7,250
100,000	2	$80,000	$160,000	$60,000	$120,000	$49,000	$25,000	$234,000	$194,000	$7,250
200,000	4	$80,000	$320,000	$60,000	$240,000	$98,000	$30,000	$448,000	$368,000	$9,240
350,000	4	$106,000	$424,000	$79,500	$318,000	$98,000	$30,000	$552,000	$446,000	$11,230

Note: Vendor indicated installation took 2 to 7 days

Note: Installation includes retrofit activities such as cutting pipe and & attaching connection flange on intake inlet pipe.

Table 3-2

Installation and Maintenance Diver Team Costs

Item	Daily Cost*	One Time Cost*	Total	Adjusted Total			
Duration			**One Day**	**One Day**	**Two Day**	**Three Day**	**Four Day**
Cost Year			**1999**	**2002**	**2002**	**2002**	**2002**
Supervisor	**$575**		$575	$627	$1,254	$1,880	**$2,507**
Tender	**$200**		$200	$218	$436	$654	**$872**
Diver	**$375**		$750	$818	$1,635	$2,453	**$3,270**
Air Packs	**$100**		$100	$109	$218	$327	**$436**
Boat	**$200**		$200	$218	$436	$654	**$872**
Mob/Demob		**$3,000**	$3,000	$3,270	$3,270	$3,270	**$3,270**
Total			**$4,825**	**$5,260**	**$7,250**	**$9,240**	**$11,230**

***Source: Paroby 1999 (cost adjusted to 2002 dollars).**

Figure 3-1

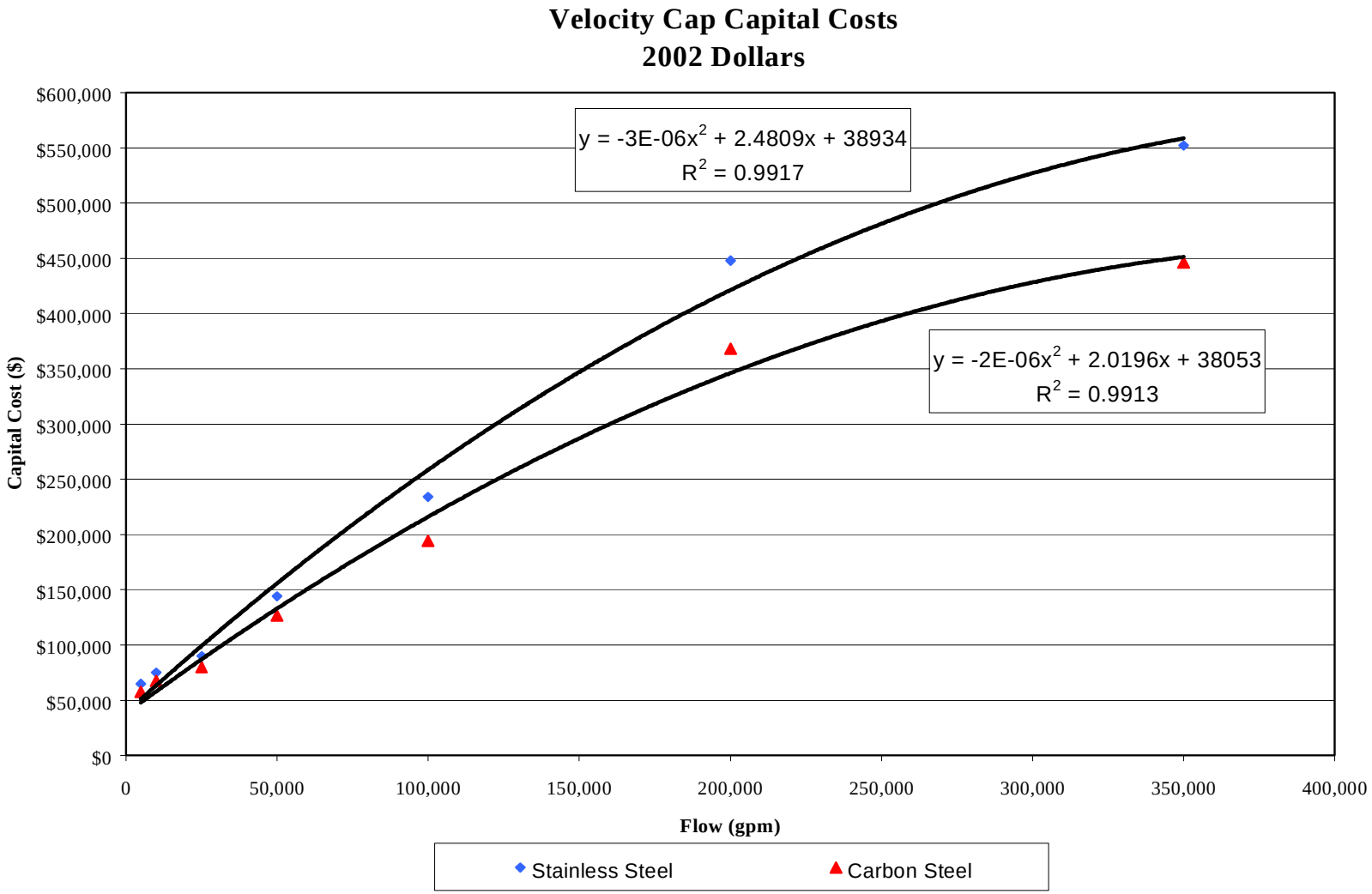
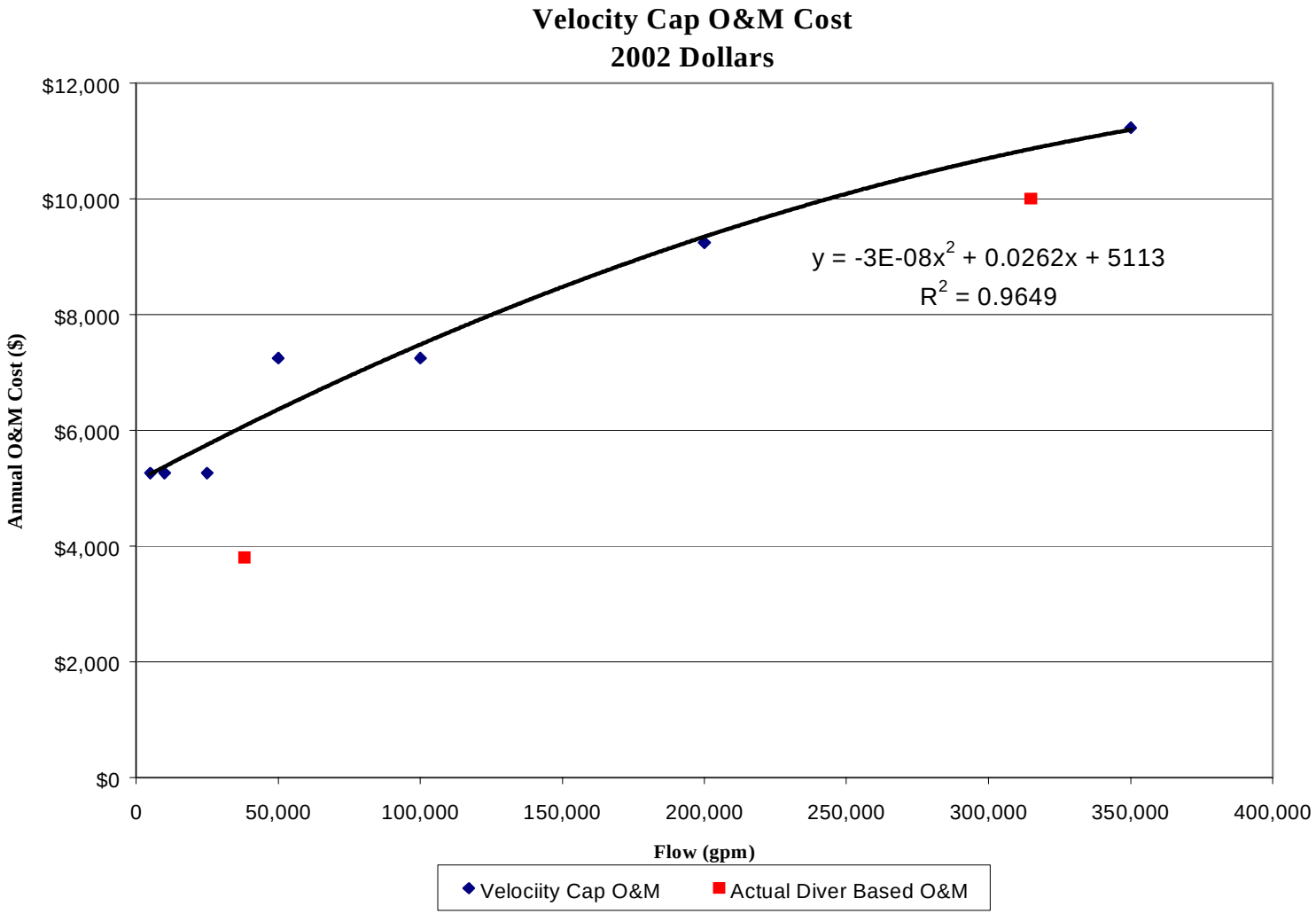

Velocity Cap Capital Costs
2002 Dollars
y = -3E-06x2 + 2.4809x + 38934
R2 = 0.9917
y = -2E-06x2 + 2.0196x + 38053
R2 = 0.9913
Capital Cost ($)
$600,000
$550,000
$500,000
$450,000
$400,000
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
Flow (gpm)
Stainless Steel
Carbon Steel

Figure 3-2


Velocity Cap O&M Cost
2002 Dollars
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
Annual O&M Cost ($)
y = -3E-08x2 + 0.0262x + 5113
R2 = 0.9649
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
Flow (gpm)
Velociity Cap O&M
Actual Diver Based O&M