

## Contents

	Page
Foreword . . . . .	vii
Pump Intake Design	
9.8 Pump intake design . . . . .	1
9.8.1 Design objectives . . . . .	1
9.8.2 Intake structures for clear liquids . . . . .	1
9.8.3 Intake structures for solids-bearing liquids . . . . .	15
9.8.4 Pump suction piping . . . . .	20
9.8.5 Model tests of intake structures . . . . .	22
9.8.6 Inlet bell design diameter (D) . . . . .	28
9.8.7 Required submergence for minimizing surface vortices . . . . .	29
9.8.8 Glossary and nomenclature . . . . .	35
Appendix A Remedial Measures for Problem Intakes . . . . . 42	
A-1 Introduction . . . . .	42
A-2 Approach flow patterns . . . . .	42
A-2.1 Open vs. partitioned structures . . . . .	42
A-3 Controlling cross-flow . . . . .	45
A-4 Expanding concentrated flows . . . . .	46
A-4.1 Free-surface approach . . . . .	46
A-4.2 Closed conduit approach . . . . .	47
A-5 Pump inlet disturbances . . . . .	48
A-5.1 Free-surface vortices . . . . .	48
A-5.2 Sub-surface vortices . . . . .	50
A-5.3 Pre-swirl . . . . .	50
A-5.4 Velocities in pump bell throat . . . . .	50
A-6 Tanks — suction inlets . . . . .	50
Appendix B Sump Volume . . . . . 54	
B-1 Scope . . . . .	54
B-2 General . . . . .	54
B-3 Minimum sump volume sequence . . . . .	55
B-4 Decreasing sump volume by pump alternation . . . . .	57
Appendix C Intake Basin Entrance Conditions . . . . . 58	
C-1 Variable speed pumps . . . . .	58
C-2 Constant speed pumping . . . . .	58

C-2.1	Inlet pipe, trench-type wet wells. . . . .	58
C-2.2	Storage in approach pipe. . . . .	58
C-3	Transition manhole, sewer to approach pipe . . . . .	59
C-4	Sluice gate . . . . .	60
C-5	Lining . . . . .	60
C-6	Design examples . . . . .	61
Appendix D	Bibliography . . . . .	62
Appendix E	Index . . . . .	63

Figures

9.8.1	— Recommended intake structure layout. . . . .	3
9.8.2	— Filler wall details for proper bay width . . . . .	3
9.8.3	— Type 10 formed suction intake . . . . .	6
9.8.4A	— Wet pit duplex sump with pumps offset . . . . .	7
9.8.4B	— Wet pit duplex sump with pumps centerline. . . . .	7
9.8.4C	— Dry pit/wet pit duplex sump . . . . .	7
9.8.5A	— Wet pit triplex sump, pumps in line . . . . .	8
9.8.5B	— Wet pit triplex sump, compact . . . . .	8
9.8.5C	— Dry pit/wet pit triplex sump. . . . .	8
9.8.6	— Trench-type wet well . . . . .	8
9.8.7	— Trench-type wet well with formed suction inlet. . . . .	9
9.8.8	— Datum for calculation of submergence. . . . .	10
9.8.9	— Definitions of V and D for calculation of submergence. . . . .	11
9.8.10	— Open bottom can intakes (pumps less than 315 l/s [5000 gpm]) . . . .	12
9.8.11	— Closed bottom can . . . . .	13
9.8.12	— Submersible vertical turbine pump . . . . .	14
9.8.13	— Open trench-type wet well . . . . .	16
9.8.14	— Open trench-type wet well for pumps sensitive to loss of prime. . . . .	16
9.8.15	— Circular wet pit with sloping walls and minimized horizontal floor area (submersible pumps shown for illustration) . . . . .	18
9.8.16	— Circular wet pit with sloping walls and minimized horizontal floor area (dry pit pumps) . . . . .	19
9.8.17	— Confined wet wall design . . . . .	20
9.8.18	— Common intakes for suction piping showing submergence datum references. . . . .	21
9.8.19	— Recommended suction piping near pump, all pump types (D = pipe diameter) . . . . .	22
9.8.20	— Examples of suction pipe fittings near pump that require approval of the pump manufacturer. . . . .	22

9.8.21 — Recommended suction piping for double suction pumps with the elbow in the same plane as the impeller shaft . . . . .	22
9.8.22 — Suction header design options . . . . .	23
9.8.23 — Classification of free surface and sub-surface vortices . . . . .	26
9.8.24 — Typical swirl meter . . . . .	27
9.8.25A — Recommended inlet bell design diameter (OD) . . . . .	30
9.8.25B — Recommended inlet bell design diameter (OD) (US units) . . . . .	31
9.8.26A — Recommended minimum submergence to minimize free surface vortices . . . . .	33
9.8.26B — Recommended minimum submergence to minimize free surface vortices (US units) . . . . .	34
A.1 — Examples of approach flow conditions at intake structures and the resulting effect on velocity, all pumps operating . . . . .	43
A.2 — Examples of pump approach flow patterns for various combinations of operating pumps . . . . .	44
A.3 — Comparison of flow patterns in open and partitioned sumps . . . . .	45
A.4 — Effect of trash rack design and location on velocity distribution entering pump bay . . . . .	46
A.5 — Flow-guiding devices at entrance to individual pump bays . . . . .	46
A.6 — Concentrated influent configuration, with and without flow distribution devices. . . . .	47
A.7 — Baffling to improve flow pattern downstream from dual flow screen . . . . .	47
A.8 — Typical flow pattern through a dual flow screen . . . . .	48
A.9 — Improvements to approach flow without diverging sump walls . . . . .	49
A.10 — Elevation view of a curtain wall for minimizing surface vortices . . . . .	49
A.11 — Methods to reduce sub-surface vortices (examples A–I) . . . . .	51
A.12 — Anti-vortex devices . . . . .	52
B.1 — Operational sequences . . . . .	56
B.2 — Pump and system head curves. . . . .	56
Tables	
Table 9.8.1 — Recommended dimensions for Figures 9.8.1 and 9.8.2 . . . . .	4
Table 9.8.2 — Design sequence, rectangular intake structures . . . . .	5
Table 9.8.3 — Acceptable velocity ranges for inlet bell diameter “D” . . . . .	21
Table C.1 — Maximum flow in approach pipes with hydraulic jump—metric units, slope = 2%, Manning’s n = 0.010. Sequent depth = 60% pipe diameter. After Wheeler (1995). . . . .	59
Table C.2 — Maximum flow in approach pipes with hydraulic jump—US customary units, slope = 2%, Manning’s n = 0.010. Sequent depth = 60% pipe diameter. After Wheeler (1995). . . . .	60