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FINAL REPORT

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STUDY ON IRRIGATION SYSTEMS REHABILITATION  
AND IMPROVED OPERATIONS AND MANAGEMENT

VOLUME 1

ACTIVITY A: REHABILITATION AND IMPROVEMENT FOR MANAGEMENT

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## TABLE OF CONTENTS

List of Figures . . . . .	iii
List of Tables . . . . .	xi
List. of Annexes . . . . .	xv
Executive Summary . . . . .	ES, 1
Recommendations . . . . .	REC, 1
 CHAPTER I	
INTRODUCTION. . . . .	1
1.1 TERMS OF REFERENCE . . . . .	1
1.2 DEFINITIONS . . . . .	2
1.3 CONCEPTS AND APPROACH . . . . .	2
1.4 STUDY FOCUS AND SCOPE . . . . .	4
1.5 METHODOLOGIES . . . . .	5
 CHAPTER II	
PLANNING AND DESIGN CHARACTERISTICS OF THE IRRIGATION SYSTEMS . . . . .	9
2.1 PROJECT DIMENSIONS AND LOCATION OF THE CANALS STUDIED WITHIN THE WHOLE SYSTEM . . . . .	9
2.2 THE UPPER CONVEYANCE SYSTEMS AT THE HEAD OF THE SUBSYSTEM STUDIED . . . . .	10
2.3 IMPACT OF THE LAYOUT OF THE CONVEYANCE SYSTEM ON THE AVAILABILITY OF WATER AT THE HEAD OF THE SUBSYSTEMS STUDIED . . . . .	11
2.4 SALIENT DESIGN FEATURES OF THE MAIN CANALS STUDIED . . . . .	13
 CHAPTER III	
ORGANIZATION AND DECISION MAKING FOR MAIN CANAL OPERATIONS . . . . .	21
3.1 INTRODUCTION . . . . .	21
3.2 THE FORMAL ORGANIZATION . . . . .	21
3.2.1 Galnewa Project: Kalankuttiya Branch Canal . . . . .	21
3.2.2 Kirindi Oya Irrigation and Settlement Project: Right Bank Main Canal . . . . .	23
3.2.3 Upper Pampanga River Integrated Irrigation System (UPRIIS): Santo Domingo Main Canal . . . . .	21
3.3 DECISION MAKING . . . . .	25
3.3.1 Mahaweli System H: Galnewa Irrigation Project . . . . .	25
Preliminary Conclusion: Impact of Organization and Decision Making on Canal Operations . . . . .	30
3.3.2 Kirindi Oya Irrigation and Settlement Project: Right Bank Main Canal . . . . .	31
Preliminary Conclusion: Impact of Organization and Decision Making on Canal Operations . . . . .	39

3.3.3	Upper Pampanga River Integrated Irrigation System (UPRIIS) . . . . .	41
	Preliminary Conclusion: Impact of Organization and Decision Making on Canal Operations . . . . .	45
3.4	CONCLUSION . . . . .	16

CHAPTER IV

	IMPACT OF PLANNING AND DESIGN CHARACTERISTICS ON THE MANAGEABILITY OF IRRIGATION SYSTEMS . . . . .	51
1.1	INTRODUCTION . . . . .	51
4.2	CONTROL OF DELIVERY FUNCTION . . . . .	54
1.2.1	Control of Water Issues at the Head of the Subsystems Studied. . . . .	55
	Conclusions of Section 4.2.1 . . . . .	73
4.2.2	Control of Water Issues from Main Canals . . . . .	76
	Conclusions, with respect to Criterion A, of Section 4.2.2 . . . . .	81
	Conclusions, with respect to Criterion B, of Section 4.2.2 . . . . .	91
	Conclusions, with respect to Criterion C, of Section 4.2.2 . . . . .	102
4.3	REGULATION OF THE CONVEYANCE FUNCTION . . . . .	103
4.3.1	Introduction . . . . .	103
4.3.2	Current Concerns and Practices of Agencies Regarding the Regulation of the Conveyance of Water in the Systems Studied . . . . .	109
1.3.3.	Conclusions of Section 4.3 . . . . .	118

CHAPTER V

	IMPACT OF PLANNING AND DESIGN CHARACTERISTICS ON THE PERFORMANCE ACHIEVED AT THE LEVEL OF THE MAIN CANAL . . . . .	121
5.1	INTRODUCTION . . . . .	121
5.2	VARIABILITY OF WATER LEVEL AT SELECTED LOCATIONS ALONG THE MAIN CANAL: IMPACT ON THE VARIABILITY OF FLOW DIVERTED . . . . .	121
5.3	VARIABILITY OF WATER VOLUMES DELIVERED AT SELECTED LOCATIONS ALONG MAIN CANAL . . . . .	130
5.4	INTER SITE COMPARISON AND CONCLUSIONS . . . . .	133
	GENERAL CONCLUSIONS . . . . .	143
	ACKNOWLEDGEMENTS . . . . .	147
	REFERENCES . . . . .	119

## LIST OF FIGURES

Figure II.1	Comparative presentation of the schematic layouts of the main systems studied . . . . .	F-1
Figure II.2	Kirindi Oya Irrigation and Settlement Project . . . . .	F-2
Figure II.3	Issue tree diagram Kirindi Oya Right Bank Main Canal . . . . .	F-3
Figure II.4	Mahaweli Ganea Development Project, System H . . . . .	F-4
Figure II.5	Kalankuttiya Block of Mahaweli System H . . . . .	F-5
Figure II.6	General Layout of UPRIS Area . . . . .	F-6
Figure II.7	Irrigation Network: Upper Pampanga River Integrated Irrigation System . . . . .	F-7
Figure II.8	Schematic diagram of Santo Domingo Area (SDA) irrigation network . . . . .	F-8
Figure II.9	Longitudinal profiles of canals studied . . . . .	F-9
Figure II.10	Kalankuttiya branch canal: Longitudinal profile . . . . .	F-10
Figure II.11	SDA main canal: Longitudinal profile . . . . .	F-11
Figure II.12	Kirindi Oya Right Bank Main Canal: Longitudinal profile . . . . .	F-12
Figure II.13	Kalankuttiya branch canal: Issue tree diagram . . . . .	F-13
Figure II.14	Kalankuttiya branch canal: Maximum expected range of water level variation above offtake invert levels . . . . .	F-14
Figure II.15	Kalankuttiya branch canal: Comparison of simulated and observed relative range of water level variation at offtakes . . . . .	F-15
Figure II.16	Hydraulic "control" and critical depth . . . . .	17
Figure II.17	Characteristic line of single baffle distributors . . . . .	F-16
Figure III.1	The Mahaweli Organization . . . . .	F-17
Figure III.2	The Mahaweli Economic Agency . . . . .	F-18
Figure III.3	Location Map of Mahaweli Systems . . . . .	F-19
Figure III.4	Project Level Organization - Mahaweli Economic Agency . . . . .	F-20
Figure III.5	Organization for Irrigation Control in Kalankuttiya Block . . . . .	F-21

Figure III.6	Organization Chart for KOISP O&M . . . . .	F-22
Figure III.7	NIA/UPRIIS organizational chart . . . . .	F-23
Figure III.8	Organization Chart for District 1 . . . . .	F-24
Figure III.9	Control of water resources . . . . .	F-25
Figure III.10	Water Delivery System (Kalawewa L.B. Main Canal, Kalankuttiya Branch Canal) . . . . .	F-26
Figure III.11	Comparison of Density of Management in three systems studied.. . . . .	F-27
Figure III.12	UPRIIS Operation rule curve . . . . .	F-28
Figure IV.1	Kirindi Oya: Daily range of variation of water level variation in the main canal near BC2 . . . . .	F-29
Figure IV.2	Kirindi Oya Right Bank Main Canal system: Cultivation calendar, December 1987 to July 1988 . . . . .	F-30
Figure IV.3	Actual and Theoretical Main Sluice Discharges, 19 March - 30 June 1988, Kirindi Oya RBMC . . . . .	F-31
Figure IV.4	Estimation of main canal oversupply, 19 March-30 June 1988, Kirindi Oya RBMC . . . . .	F-32
Figure IV.5	Kirindi Oya: Spatial variation of daily rainfall at Lunugamwehera and Wirawila, 19 March to 30 June 1988, Right Bank Plain Canal . . . . .	F-33
Figure IV.6	Schematic layout of Kalawewa Left Bank Main Canal . . . . .	F-34
Figure IV.7	Record of tank water levels, main sluice gate openings and average daily discharge in branch canal, measured in MS1, Kalankuttiya, Yala 1988 . . . . .	F-35
Figure IV.8	Actual and planned daily water delivery near the head (at MS1) of Kalankuttiya branch canal in Yala 1988. Delivery expressed in terms of mean discharge . . . . .	F-36
Figure IV.9	Actual and planned daily water delivery near the head (at MS1) of Kalankuttiya branch canal in Yala 1988. Delivery expressed in terms of depth over the cultivated area . . . . .	F-37
Figure IV.10	Water level and discharge at gauge MS1, Kalankuttiya branch canal, 08-14 May . . . . .	F-38
Figure IV.11	SDA main canal Headgate, data logging station . . . . .	F-39

Figure IV.12	SDA, Discharges at Headgate, 12 to 22 September 1988 . . .	F-40
Figure IV.13	SDA Headgate: Calibration of 15 ft Parshall flume . . .	F-41
Figure IV.14	SDA Headgate (15 ft Parshall flume): Comparison of discharge assessed using NIA table (Q <sub>NIA</sub> ) with IIMI gauging (Q <sub>meas</sub> ) . . . . .	F-42
Figure IV.15	SDA Headgate Parshall flume: Effect of submergence . .	F-43
Figure IV.16	Sketch of data logging station, Pilot Area (DC1, Tract 2), Rajangana left bank main canal . . . . .	F-44
Figure IV.17	Sketch of data logging station, Pilot Area (DC2, Tract 21, Rajangana left bank main canal . . . . .	F-45
Figure IV.18	Water levels in Main and D-Canal, pilot area, Rajangana: 02 Aug to 09 August . . . . .	F-46
Figure IV.19	Sketch of SDA Lateral B measurement site . . . . .	F-47
Figure IV.20	Sketch of SDA Lateral G measurement site . . . . .	F-48
Figure IV.21	SDA, Daily discharges near Lateral B, 21 July to 07 October 1988 . . . . .	F-49
Figure IV.22	SDA, Daily discharges near Lateral G, 24 August to 07 October 1988 . . . . .	F-50
Figure IV.23	SDA, Rotational Irrigation schedule with effect from 12 September 1988 . . . . .	F-51
Figure IV.24	SDA, Daily discharge into Lateral B as a percentage of flow in main canal, 21 July to 07 October 1988 . .	F-52
Figure IV.25	SDA, Daily discharge into Lateral G as a percentage of flow in main canal, 23 August to 07 October 1988 . . .	F-53
Figure IV.26	SDA (near Lateral B), Interventions at rated regulator and impact on flow sharing, 24 - 31 July 1988 . . . . .	F-54
Figure IV.27	SDA, Discharges into Lateral B as a percentage of flow in main canal . . . . .	F-55
Figure IV.28	SDA, Distribution of flow in Lateral B as a percentage of flow in main canal, 24 to 31 July 1988 . . . . .	F-56
Figure IV.29	Kalankuttiya branch canal: Plan of data logging station near distributary canals 305D3 and 308D2 . . . . .	F-57
Figure IV.30	Longitudinal section near the head of distributary canal 308D2 . . . . .	F-58

Figure IV.31	Cross sectional view of offtake of distributary canal 305D3 . . . . .	F-59
Figure IV.32	Kalankuttiya, Water level variations near DB-Weir 1, 21 to 24 June 1988. . . . .	F-60
Figure IV.33	Kalankuttiya, Water level variations near DB-Weir 1, 28 June to 01 July 1988 . . . . .	F-61
Figure IV.34	Schematic diagram of data logging station at Distributary Canal (DC5), Tract 1, Iirindi Oya Right Bank Main Canal	F-62
Figure IV.35	Schematic diagram of data logging station Branch Canal 2 (BC2), Tract 5, Iirindi Oya Right Bank Main Canal	F-63
Figure IV.36	Sketch of DC5 and BC2 canal command areas and operational responsibilities of ID personnel, Kirindi Oya Right Bank Main Canal and accompanying note . . . . .	F-64 F-65
Figure IV.37	SDA Lateral B, Calibration of 10 ft Parshall flume . . . . .	F-66
Figure IV.38	SD4 Lateral G, Tentative calibration of 4 ft Parshall flume . . . . .	F-67
Figure IV.39	SDA Lateral B (10 ft Parshall flume) Comparison of discharge assessed using NIA table (QNIA) with IIMI gauging (Qmeas) . . . . .	F-68
Figure IV.40	SDA Lateral G (4 ft Parshall flume) Comparison of discharge assessed using NIA table (QNIA) with IIMI gauging (Qmeas) . . . . .	F-69
Figure IV.41	Iirindi Oya Right Bank Main Canal: Water surface profile in reach GR12-GR13, assuming water level at GR13 maintained at FSD . . . . .	F-70
Figure IV.42	Simulated range of water level variation at the offtakes while level at downstream cross regulator varies. Reach GR12-GR13, Kirindi Oya RBMC . . . . .	F-71
Figure IV.43	Relative range of water level variation expected above offtake invert levels, Reach GR12-GR13, Kirindi Oya RBMC	F-72
Figure IV.44	Kirindi Oya Right Bank Main Canal: Water levels and gate interventions near DC5, 12-20 May 1988 . . . . .	F-73
Figure IV.45	Kirindi Oya Right Bank Main Canal: Frequency distribution of water levels in main canal at GR3. . . . .	F-74
Figure IV.46	Kirindi Oya Right Dank Main Canal: Cumulative Frequency distribution of water levels in Main Canal at GR3 . . . . .	F-75

Figure IV.47	Iirindi Oya Right Bank Main Canal: Frequency distribution of water levels in Main Canal at GR12 . . . . .	F-76
Figure IV.48	Kirindi Oya Right Bank Main Canal: Cumulative Frequency distribution of water levels in Main Canal at GR12 . . . . .	F-77
Figure IV.49	Kirindi Oya Right Bank Main Canal: Water levels and gate interventions near DC5, 20-28 March 1988. . . . .	F-78
Figure IV.50	Iirindi Oya Right Bank Main Canal: Water levels, gate interventions and flows near BC2, 04-12 May 1988 . . . . .	F-79
Figure IV.51	Water surface profiles along a canal: two typical situations . . . . .	F-80
Figure IV.52	Kalankuttiya branch canal: Special issue of water to the tail end on 20 May 88. Discharges at MS1 and in 307 D3 . . . . .	F-81
Figure IV.53	Kirindi Oya RBMC Observations at cross regulators GR3 and GR12 of the propagation of a wave released at 06H30 from the dam . . . . .	F-82
Figure V.1	Kalankuttiya: branch canal water levels recorded every 10 minutes by the dataloggers at DBW1 and tailend during 4 typical rotations . . . . .	F-83
Figure V.2	Kalankuttiya: Discharges into distributary canals 305D3 and 307D3 during the rotations R1, R2, R11, and R12 . . . . .	F-84
Figure V.3	Kalankuttiya branch canal: Daily range of water level variation near duck-bill weir 1, 09 May to 24 Sep 1988. . . . .	F-85
Figure V.4	Kalankuttiya branch canal: Daily range of water level variation near the tail end, 09 May to 24 Sep 1988 . . . . .	F-86
Figure V.5	Kalankuttiya: Daily coefficient of variation of water level in the branch canal (near DBW1) . . . . .	F-87
Figure V.6	Kalankuttiya: Daily coefficient of variation of water level in the branch canal at the tail end . . . . .	F-88
Figure V.7	Kalankuttiya: Coefficient of variation of water level in the branch canal during each rotation . . . . .	F-89
Figure V.8	Kalankuttiya: Coefficient of variation of discharge in distributaries 305 D3 and 307 D3 during each rotation . . . . .	F-90



Figure V.9	Kalankuttiya: Impact of water level variations in branch canal on variation of discharge into distributary canal 307D3 . . . . .	F-91
Figure V.10	Kalankuttiya: Impact of water level variations in branch canal on variation of discharge into distributary canal 305D3 . . . . .	F-92
Figure V.11	Kirindi Oya: Daily range of water level variation in the main canal near DC5, 06 March to 29 June 1988 . . .	F-93
Figure V.12	Kirindi Oya: Daily range of water level variation in the main canal near BC2, 06 March to 29 June 1988 . . .	F-94
Figure V.13	Kirindi Oya: Daily coefficient of variation of water level in the main canal near distributary canal DC5 . . . . .	F-95
Figure V.14	Kirindi Oya: Daily coefficient of variation of water level in the main canal near branch canal BC2 . .	F-96
Figure V.15	Kirindi Oya RBMC: Water levels near DC5 and BC2, 16-24 April 1988 . . . . .	F-97
Figure V.16	Kirindi Oya: Comparison of daily coefficient of variation of water level in main canal and coefficient of variation of discharge in DC5 . . . . .	F-98
Figure V.17	Kirindi Oya: Comparison of daily coefficient of variation of water level in main canal and coefficient of variation of discharge in BC2 . . . . .	F-99
Figure V.18	Rajangana : Daily coefficient of variation of water level in the left bank main canal . . . . .	F-100
Figure V.19	Rajangana: Daily range of water level variation in the pilot distributary canal upstream of the baffle distributor . . . . .	F-101
Figure V.20	Rajangana: Daily range of water level variation in the main canal near the control distributary canal . . . .	F-102
Figure V.21	Rajangana: Daily coefficient of variation of water level in main canal near control distributary canal and in pilot distributary canal . . . . .	F-103
Figure V.22	Rajangana: Daily coefficient of variation of discharge in pilot and control distributary canals . . . . .	F-104
Figure V.23	SDA: Daily coefficients of variation of water level in the main canal at the Headgate and near Laterals B and G	F-105

Figure V.21	SDA: Daily coefficients of variation of discharge in the main canal (at the Headgate) and into laterals B and G	F-106
Figure V.25	SDA: Comparison of daily coefficients of water level in the main canal and discharge in Lateral B . . . . .	F-107
Figure V.26	Kalankuttiya Branch Canal, Yala 1988, Comparison of rotational deliveries (average) at three locations . .	F-108
Figure V.27	Kalankuttiya Branch Canal, Yala 1988. Comparison of rotational deliveries (cumulative) at three locations .	F-109
Figure V.28	Kalankuttiya: spatial variation of daily rainfall between head and tail of system . . , . . . . .	F-110
Figure V.29	Kalankuttiya BC: Water deliveries to individual distributary canals during rotations R1 and R1, Yala 1988	F-111
Figure V.30	SDA, sharing of water deliveries at Lateral B for different periods of inflow, 21 July to 07 October 1988.	F-112
Figure V.31	SDA, Comparison of average seasonal water delivery at different locations, 21 July to 07 October 1988 . . . .	F-113
Figure V.32	SDA, Comparison of average water delivery at different locations, 12 September to 07 October 1988 .	F-114
Figure V.33	Comparison of standard deviation of water level in the main canal across all sites studied . . . . .	136
Figure V.31	Comparison of coefficient of variation of water level in the main canal across all sites studied . . . .	138
Figure V.35	Comparison of coefficient of variation of discharge in distributaries across all sites studied . . . . .	139

## LIST OF TABLES

Table I.1	List of canals studied with reference to the projects and systems . . . . .	6
Table I.2	List and locations of the recording stations used for the study . . . . .	T-1
Table II.1	The location of the sub-systems studied within the entire projects . . . . .	T-2
Table II.2	Physical characteristics of the canals studied . . . . .	T-3
Table II.3	Lengths and slopes of the main canals and density of structures across the canals . . . . .	13
Table II.4	Potential flexibility for "checking" provided by the design . . . . .	16
Table 1.11.1	Irrigation Water Weekly Evaluation . . . . .	15
Table IV.1	Control of water issues at the head of the sub-systems	56
Table IV.2	Control of water issues from main canal . . . . .	57
Table IV.3	Kirindi Oya Right Bank Main Canal: Data used by Irrigation Department to compute irrigation water requirements . . . . .	58
Table IV.4	Kirindi Oya Right Bank Main Canal system: Record of daily rainfall and daily main sluice discharges . . . . .	T-3
Table IV.5	Kalankuttiya branch canal: Summary of main sluice interventions, Yala 1988 . . . . .	T-5
Table IV.6	Water levels and corresponding discharge rates recorded at staff gauge MS1, Kalankuttiya branch canal, 08-14 May 1988 . . . . .	T-6
Table IV.7	SDA Headgate: Comparison of discharge estimates by current metering and from NIA's table and accompanying note . . . . .	T-7 T-8
Table IV.8	Daily discharge rate and volume distribution near SDA Lateral B, 21 July-07 October 1988 . . . . .	T-9 T-10
Table IV.9	SDA main canal at the Lateral B branching point, 24-31 July 1988: History of interventions and impact on flow sharing . . . . .	T-11
Table IV.10	Evaluation of capacity to assess flow delivered to distributary canals, Kalankuttiya branch canal, Yala 1988	T-12

Table IV.11	Physical condition of structures. Iirindi Oya Right Bank Main card . . . . .	T-13
Table IV.12	SDA Lateral B, Comparison of discharge estimates by current metering and NIA's table . . . . .	T-11
Table XV.13	SDA Lateral G, Comparison of discharge estimates by current metering and NIA's table . . . . .	T-15
Table IV.14	Daily water delivery statistics, SDA Lateral 5, 21 July-07 Oct 1988 . . . . .	T-16
Table IV.15	Daily water delivery statistics, SDA Lateral G, 21 July-07 Oct 1988 . . . . .	T-17
Table IV.16	SDA: Comparison of theoretical and actual dimensions of concrete Parshall flumes at the Headgate and Laterals B and G . . . . .	88
Table IV.17	Rajangana: Water balance of distribution of water along pilot distributary canal, 25 May 1988 . . . . .	91
Table IV.18	Simulated water level variation in reach GR12-GR13, Kirindi Oya Right Bank Plain Canal . . . . .	93
Table IV.19	Intensity of operations at two diversions along the Kirindi Oya Right Bank Plain Canal . . . . .	T-18
Table IV.20	Kalankuttiya branch canal: Frequency of interventions at two identically regulated diversions from 9 May 1988 to 10 September 1988 . . . . .	99
Table IV.21	Regulation of conveyance systems . . . . .	110
Table IV.22	Water issues from Kalawewa and other tanks in Mahaweli System H, Yala 1988. . . . .	T-19
Table V.1	Kalankuttiya: Daily coefficients of variation of branch canal water level at DBW1, and daily coefficients of variation of discharge into distributary canal 305D3 . . . . .	T-20
Table V.2	Kalankuttiya: Daily coefficients of variation of branch canal water level at the tail end, and daily coefficients of variation of discharge into distributary canal 307D3 . . . . .	T-21
Table V.3	Kalankuttiya: Comparison of coefficients of variation of branch canal water level at DBW1 and at the tail end during rotational periods of water issue . . . . .	T-22
Table V.4	Kalankuttiya: Comparison of coefficients of variation of discharge into distributary canals 305D3 and 307D3 during rotational periods of water issue . . . . .	T-23

Table V.5	Iirindi Oya RBMC: Daily coefficients of variation of main canal water level at the GR3:DC5 location, and daily coefficients of variation of discharge into distributary canal DC5 . . . . .	T-21
Table V.6	Kirindi Oya RBMC : Daily coefficients of variation of main canal water level at the GR3:BC2 location, and daily coefficients of variation of discharge into branch canal BC2 . . . . .	T-25
Table V.7	Kirindi Oya RBMC: Cross-regulator interventions and average daily coefficients of variation of main canal water level at the two locations GR3:DC5 and GR12:BC2 .	126
Table V.8	Rajangana : Daily coefficients of variation of water level in the pilot distributary canal, and daily coefficients of variation of discharge into the pilot distributary canal. . . . .	T-26
Table V.9	Rajangana : Daily coefficients of variation of main canal water level at the control distributary canal, and daily coefficients of variation of discharge into the control distributary canal . . . . .	T-27
Table V.10	SDA : Daily coefficients of variation of main canal water level and discharge at the headgate . . . . .	T-28
Table V.11	SDA : Daily coefficients of variation of main canal water level near Lateral B, and daily coefficients of variation of discharge into Lateral B . . . . .	T-29
Table V.12	SDA : Daily coefficients of variation of main canal water level near Lateral G, and daily coefficients of variation of discharge into lateral G . . . . .	T-30
Table V.13	Rotational values of delivery height (volume/days) of Kalankuttiya Branch Canal, Yala 1988 . . . . .	T-31
Table V.14	Rotational values of cumulative delivery height (volume/area) of Kalankuttiya Branch Canal, Yala 1988 .	T-32
Table V.15	Pattern of daily water volume distribution along the Kalankuttiya branch canal for two selected water issue periods, R1 and R4, Yala 1988 . . . . .	T-33
Table V.16	Water deliveries along Kalankuttiya branch canal for two selected water issue periods, R1 and R4, Yala 1988 . .	T-34
Table V.17	Kalankuttiya : Estimation of water lost due to leak through the head sluice gate during non water issue periods, as measured at staff gauge MS1 . . . . .	T-35

Table V. 18	Daily average water delivery per unit cultivated area during each period of inflow along SDA Main Canal . . . .	T-36
Table V.19	Summarizes the water deliveries to distributary canal DC5 and to branch canal BC2, which are part of the two studs-locations GR3:DC5 . . . . . , . . . . .	T-37
Table V.20(a)	Comparison of daily standard deviations (STD) and daily coefficients of variation (CV) of water level in main canal and coefficients of variation of discharge in distributary canal across all locations studied . . . .	135
Table V.20(b)	Ranking of study locations in descending order of performance . . . . . , . . . , . . . . . , . . . . .	<b>133</b>
Table V.1	Average daily water delivery per unit cultivated area for all locations studied . . . . .	140

## LIST OF ANNEXES

Annex III.1	A rotation during the week beginning 12 September, 1988	A-1
Annex III.2	List of Acronyms . . . , . . . . . , . . . . .	A-7
Annex IV.1	Background note to demonstrate impact of automatic downstream control gate and baffle distributor on control of water flows into the pilot distributary canal at Rajangana . . . , . . . . .	A-9
ANNEX IV.2	Background note to demonstrate the impact of submergence of the measuring weir on estimation of discharge at the head of branch canal 2, Kirindi Oya Right Bank Main Canal . . . . .	A-15
ANNEX IV.3	Typical analysis of data set acquired at Kirindi Oya RBMC/BC2 logging station, 27-28 March 1988 . . . . .	A-21
ANNEX V.1	Kalankuttiya: Sensitivity of discharge in distributary canal 307D3 to water level variations in branch canal .	A-31
ANNEX V.2	Frequency distributions of coefficient of variation of discharge in the distributary/main canals studied . . .	A-37

## EXECUTIVE SUMMARY

Improvement in Plain System Management has been identified as a key to better performance of irrigation systems. This aspect of Irrigation Management deserves more professional attention and research.

The objective of the present study is to document with a management-oriented approach the reality of main canal operations with particular reference to the implications of the planning and design of main systems on the management and performance of the systems. Main canal regulation has been analyzed from the point of view of (a) its impact on the distribution of flows from the main canal, (b) its contribution to the manageability and ability to operate the physical systems, and (c) its implications for the managerial requirements of the irrigation agencies.

IIMI has conducted a comparative study of three irrigation systems in Sri Lanka and one in the Philippines, which display different planning and design features in their main systems and canals. These are: (a) the Kalankuttiya Branch Canal of the Galnewa Project in System H of the Mahaweli Economic Agency of the Mahaweli Authority of Sri Lanka; (b) the Right Bank Main Canal (RBMC) of the Kirindi Oya Irrigation and Settlement Project (KOISP) of the Irrigation Department, Sri Lanka; (c) the Rajangana Pilot Distributary Canal of the Rajangana Irrigation Scheme of the Irrigation Department, Sri Lanka; and (d) the Santo Domingo Area (SDA) Plain Canal of the Upper Pampanga River Integrated Irrigation System (UPRIIS) of the National Irrigation Administration (NIA) of the Philippines.

The study analyzes the impact of the physical aspects of the systems, including the structuring of main systems and canals, on (a) the organizational setup of the Irrigation Agencies in charge of their operations, and (b) the manageability of the two interrelated primary functions of a main canal, namely the conveyance of water from a source of supply to remote places of delivery to sub-units of the system.

Field investigations and analyses have been conducted to examine (a) the actual conditions under which canal operators exert control over the physical process, the flow of water, and (b) the actual conditions under which the management process of decision making takes place at the various operational levels of the agency as required for canal regulation.

Most of the information utilized for the study was collected during one irrigation season in 1988. This was performed through (a) intensive automatic recording of canal water levels using electronic data-logger technology, as well as classical staff-recorders (a total of 31 different sensing points were dispersed at key locations along the main canals and at some branching points), (b) careful field monitoring of canal operations, and (c) interviews of the operations staff. The study also drew upon previous work conducted by IIMI on the same systems as well as results generated by simulations performed through available mathematical models of some of the canals.



## A. The Impact of Planning and Design on the Management of the Conveyance of Water in the Main Canals Studied

The main canals studied correspond to subsystems of much larger projects. With the exception of the Kirindi Oya Right Bank Main Canal, which takes off directly from a main storage reservoir, the canals studied were dependent for their supply on an upper conveyance system. In the case of the Kalankuttiya Branch Canal, the upper conveyance system consists of a cascade of 3 tanks, namely, Kalankuttiya, Mulannatuwa, and Kalawewa. The last tank is itself supplemented by a diversion from the Mahaweli River. In the case of the Santo Domingo Area Main canal, the upper conveyance system is characterized by a cascade of 5 diversions along the 50 km long water course and diversion canal (DC#1) between the source of supply and the head of the canal studied (SDA Main Canal). In the case of Rajangana the canal studied is a distributary canal taking off the upper reaches of a main canal.

The following design characteristics were identified as important parameters that constitute the foundation for more decentralized operations at the head of subsystems:

A1. Decentralized storage capacities such as in Mahaweli System H can improve the manageability of extended systems. This was evidenced by the higher level of performance achieved in System H, in terms of the quantitative control of the supply at the head of the subsystem, when compared with the Diversion Canal DC#1 at UPRIIS.

At Kalankuttiya, during yala (dry season) 1988 the management of the left bank main canal (conveyance system) succeeded, with limited managerial effort, in refilling the Kalankuttiya Tank in due time without affecting the program of water issues from the tank. This result, however, has to be weighed against the difficulties experienced previously at a time of water shortage (maha, or wet season, 1986/87). This shortage put exceptional strain on the conveyance system and on its management, which found itself relatively unprepared to face such a situation with its usual managerial practices.

At the UPRIIS, on the contrary, the supply provided at the head of the SDA Main Canal depends largely on the performance of the upper conveyance system (DC#1). In 1988, the supply at the head of the SDA was very irregular despite the considerable managerial efforts deployed by the staff of the Water Central Coordinating Center of the UPRIIS/NIA, assisted by the District Hydrologist and supported by an effective radio communication system. The supply conditions at the head of the system make it almost futile for the Agency to envisage distributing water within the Santo Domingo Area with the objective of quantitative flow control as in the case of Kalankuttiya. Instead, it was observed that the distribution was implemented with a rather high degree of success on the basis of a "degraded" objective, that, is, to share whatever inflow is available in proportion to the planted areas.

A2. The rational use of hydraulic "controls" (e.g., long-crested weirs) across canals, if permitted by the topography, as an alternative option to manual water level control through gated cross-regulators, was found to have

a significant impact on the staffing and manageability of the systems. Reasons for this include: (a) simple hydraulics and simple operations; (b) reduced room for decision making at the level of the operators while nevertheless improving the quality of the water level control in the main canal, which in turn conditions the decision making and operations at the oftakes aimed at flow control; (c) opportunity for decentralized operations of the delivery function, relatively uninfluenced by the operations related to the conveyance of water in the main canal.

It was observed, in Kirindi Oya, that the excessive operational flexibility available at the diversion point from a main canal (gated cross-regulator plus lateral oftake) was abused to the detriment of conditions for effective management of the conveyance of water throughout the main canal. A likely explanation is that the present concern of gate operators is limited to the distribution of water; they have little or no concern for the conveyance of water along the main canal.

It was also observed that although "controls" are seldom used as level control devices, they are more readily **used** as measuring devices, but sometimes with limited success.

"Controls" in the form of duckbill weirs existing at the Kalankuttiya Branch Canal, (and on the Rajangana Pilot canal) were found to be effective in creating hydraulic conditions (control of level) suitable for the control of water issues at the oftakes while eliminating the burden of gate operations on the main canal and all its 'negative consequences. Under such a conditioning environment in the main canal, further gain of performance in the control of flow could be envisaged through technological innovations such as baffle distributors, provided of course that the process of technology transfer has been adequately effected.

#### B. Performance of the Conveyance System: A Conditioning Factor for the Control of Water Delivery

The planning and design features referred to above were found to have an impact on the performance of the conveyance of water along canals, a factor that conditions the control of the water delivery. Other managerial conditions required for the control of water issues that were examined were: (a) the availability of explicit delivery targets, (b) the possibility of obtaining feedback on the actual flows delivered, and (c) the availability of physical means for operations.

B1. At the head of the canals studied, these conditions were generally found to be adequate, with the exception of the SDA. The poor performance of the SDA bin canal in that respect was essentially conditioned by the inadequately regulated sources of its supply: (a) the local flow from a creek, and (b) the irregular supply from the upper conveyance system. As a result, the delivery objective within the Santo Domingo Area during the 1988 wet season (which in fact turned out to be relatively water short) was found to be limited to the equitable sharing of available water and apparently not the provision of controlled water issues like in the other systems.

02. The general observation in the systems studied was that the managerial conditions required for the control of delivery at the offtakes were deficient. This deficiency can be attributed in part to the design features of the canals that often include ineffective devices to assess the flow diverted. Of more importance, however, are the deficiencies of the present regulating mechanisms for the conveyance of water along the canals and the difficulties in achieving this with the current practices of operation of the gated cross-regulators. This gap was of particular significance at Kirindi Oya Right Bank Main Canal, as the hydraulics and the length of the canal make it difficult to perform efficiently the downstream mode of regulation attempted by the Agency. But even in the Rajangana Pilot Distributary Canal where this function could have been performed more easily, the Agency did not seem to have taken advantage of the technology to **manage** the conveyance function better, and in particular to monitor the inflow-outflow water balance along the canal.

### C. General Findings and Conclusions

As a result of the investigations carried out in the four systems, some general conclusions were arrived at as follows:

C1. The territorial magnitude of extensive irrigation projects is reflected in the dimensions of the **organizational** setup of their management agencies.

C2. The potential complexity of the management is not only determined by the size and structure of the organizations but also to a large extent by the layout of the main system and the hydraulics of the canals. It may also happen, however, that even in a system of limited size with an organization of corresponding magnitude, such as the Kirindi Oya Right Bank Main Canal, the canal hydraulics might still be highly complex. Appropriate managerial practices are therefore needed to cope with this complexity. The operation of systems in a dynamic manner while maintaining the objective of an acceptable level of performance generally results in a higher degree of complexity of the management.

C3. There are both a parallel and a link between the physical infrastructure of the irrigation main system and the superimposed organizational arrangements of the agency to manage the water from the source to the various points of delivery.

C4. The parallel refers to the relative degrees of centralization versus decentralization available in both the agency and the physical system to control the complex process of decision making and the actions to be performed at various hierarchical levels with a view to the effective conveyance and distribution of water. The conveyance system of the Mahaweli System H, including a cascade of intermediate storage tanks, is an example of a main system with opportunities for decentralized operations of subsystems. In contrast, the conveyance system that provides the supply to the Santo Domingo Area Main Canal is directly dependent on the operations of a central reservoir.