

1988年トリニダッド・トバゴは、全国的に降雨量が例年に比べ少なく、記録的な渇水を経験した。この渇水の原因として、

- ① 都市化が進み、水需要が伸びている。
- ② 柔軟性のある水運用がなされていない。
- ③ 均等な給水がなされていない。
- ④ 漏水が多い。

等が考えられる。

現在、トリニダッド島の給水事情は1983年に Caroni-Arena システムが全面的に稼働し、その他にも地表水、地下水を水源とする浄水施設が次々と完了したことにより大幅に改善されている。しかしながら、人口密集地域の一部では、相変わらず水圧不足が生じており、上述の乾季の渇水対策とも関連し、既存給水システムをより効率的に管理し、適正な水供給を行うことが緊急課題となっている。

上下水道事業局 (WASA) は1980年11月、こうした課題に対処するため中央監視システム (Central Supervisory System:CSS) を導入し、主要な水源、浄水場、ポンプ等の運転状況を監視している。

既存 CSS は水源浄水場及び送水ポンプ場を対象としており、配水施設の運転状況のデータはモニターされていない。これら配水池・配水ポンプ場・配水管の管理を効果的に行うために、CSS の整備・拡充が必要となっている。

WASA としては CSS システムをトリニダッド島全域、さらにはトバゴ島まで拡大することを将来計画としている。

#### 4-3 上水道分野における経済・技術協力の状況

近年、WASA の水道事業に対し行われた経済、技術協力には以下のようなものがある。

##### (1) 情報システム開発・計画 TRI /84/003/F/01/14 (Assistance to WASA)

出資元 UNDP (PAHO)

期 間 1984～1988

費 用 US\$ 335,450

内 容 新しい情報システム開発により計画・管理面における WASA の運営に協力する。カロニ川水質汚染対策調査を含む。

##### (2) 漏水対策等調査

出資元 IDB

期 間 1984～1988

費 用 -

内 容 トバゴ島の上下水道システムの拡張, 家庭用メーターリングの費用・便益  
調査給水施設マッピングシステム

(3) Lambeau Hill 水道計画 (Lambeau Hill Water Project)

出資元 EDF (EEC)

期 間 1984～実施中

費 用 US\$ 750, 000

内 容 トバゴ島 Lambeau Hill に配水池を建設する。

(4) トリニダット・トバゴ給水計画 (予定)

(Trinidad and Tobago Water Suplly Project)

出資元 フランス

期 間 18カ月

費 用 F.FR. 374, 700, 000

Million FRF

1. Master Plan 12.9

2. Point Fortin

・ Updating & Supervision 3.8

・ Supply & Construction 101.4

・ Pumping Station 7.4

112.6

3. Richmond Hill Scheme

・ Design 12.3

・ Dam 124.5

・ Treatment Plant 27.1

・ Pumping Station 8.7

・ Pipeline 69.8

・ Supervision 6.8

249.7

374.7

1 TT\$ = 1.5 FF

1 US\$ = 4.2 TT\$

## 内 容

- |                                                                   |          |
|-------------------------------------------------------------------|----------|
| 1. Preliminary Study-Data Collection                              | -1.5ヵ月   |
| 2. Water Demand                                                   | - 2 カ月   |
| 3. Surface Water Study                                            | - 5 カ月   |
| 4. Ground Water Study                                             | - 5 カ月   |
| -Discussion with WASA-                                            |          |
| 5. Identification and Pre-selection of<br>Alternative Schemes     | - 1 カ月   |
| 6. Economic Comparison and Phasing of the<br>Pre-selected Schemes | -2.5ヵ月   |
| -Discussion with WASA-                                            |          |
| 7. Preliminary Design of the Most Urgent Schemes                  | - 3 カ月   |
| 8. Financial, Institutional and Management Studies                | -1.5ヵ月   |
| 9. Preparation of the Construction Phase                          | -1.5ヵ月   |
| ( 報告書 )                                                           |          |
| Interim Report No.1                                               | - 6 カ月後  |
| Interim Report No.2                                               | -12 カ月後  |
| Draft Final Report                                                | -16.5ヵ月後 |
| Final Report                                                      | -18 カ月後  |
| ( 関連コンサルタント )                                                     |          |
| Spie Batignolles                                                  |          |
| ☆Seureca                                                          |          |
| Pont-A-Mousson                                                    |          |
| Degremont                                                         |          |

# WATER AND SEWERAGE AUTHORITY HIGHER ORGANISATION STRUCTURE

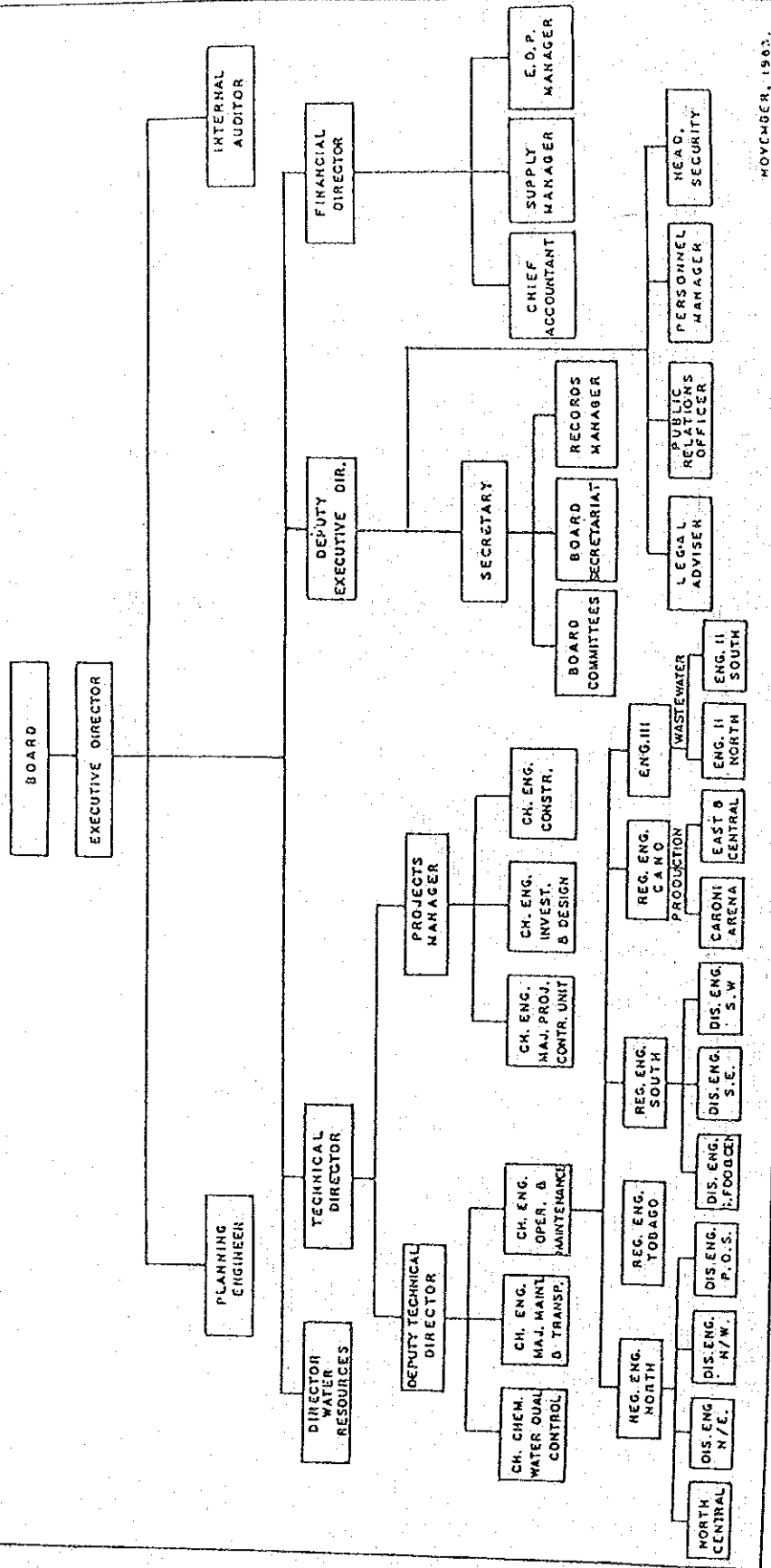
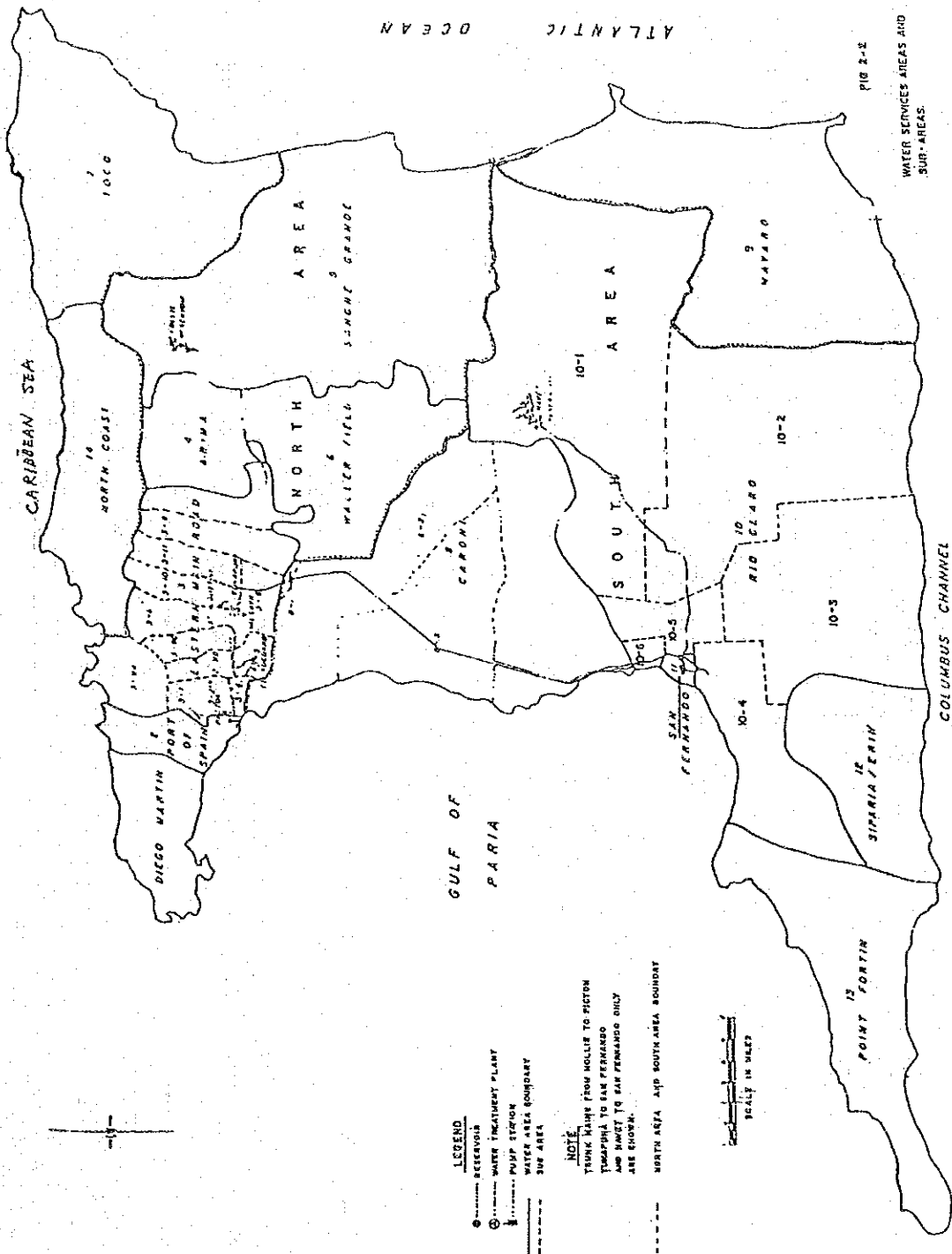


圖 4-1 上下水道事業局 (WASA) 組織圖



出所: WASA

図4-2 トリニダード島給水地域

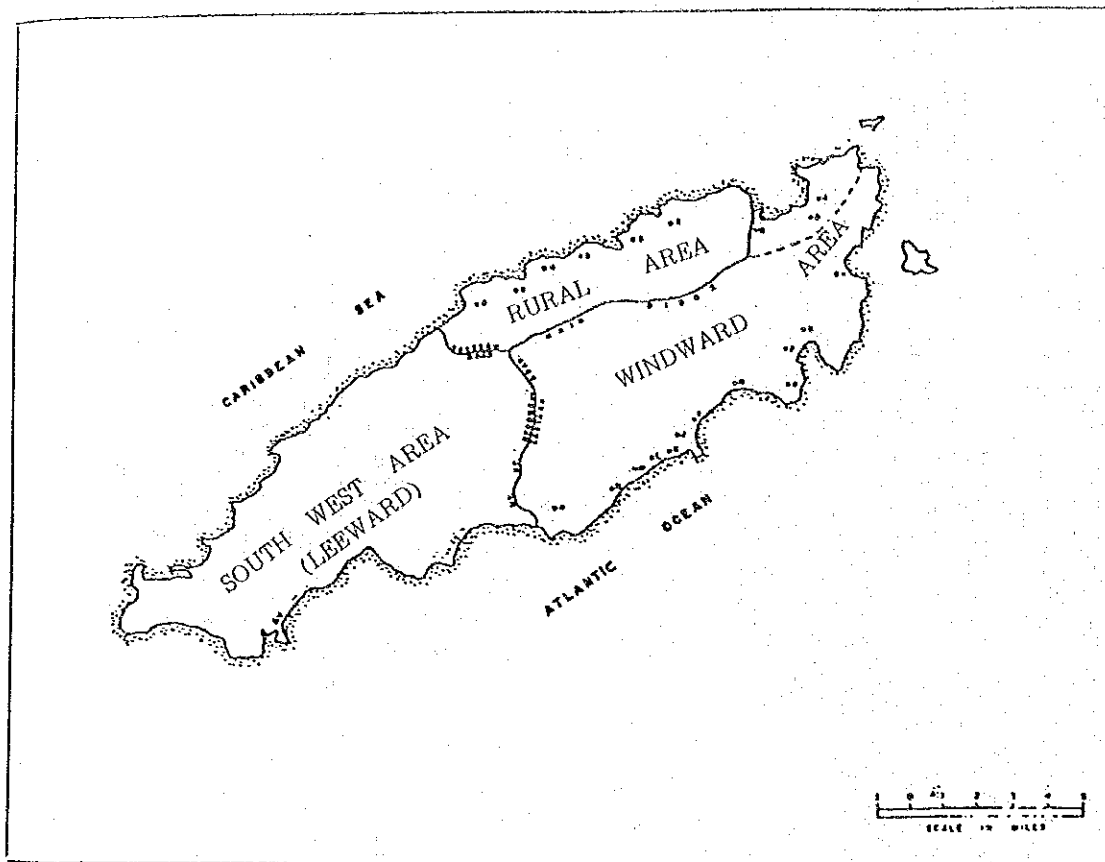


図4-3 トバゴ島の給水地域

出所：WASA

# Stepping Up ..... and Up

WASA means WATER and perhaps there is no better way to show it than through representation of our production record since our establishment in 1965.

Like steps, we move up almost always — the only exceptions being 1966 when salt water intrusion occurred, and the drought years of 1973 and 1978.

And our proudest achievement of all, an *improvement* in 1987 — the long, harsh drought year which turned out to be the worst since 1973.

So we are proud to acclaim — WASA's Stepping Up and Up.

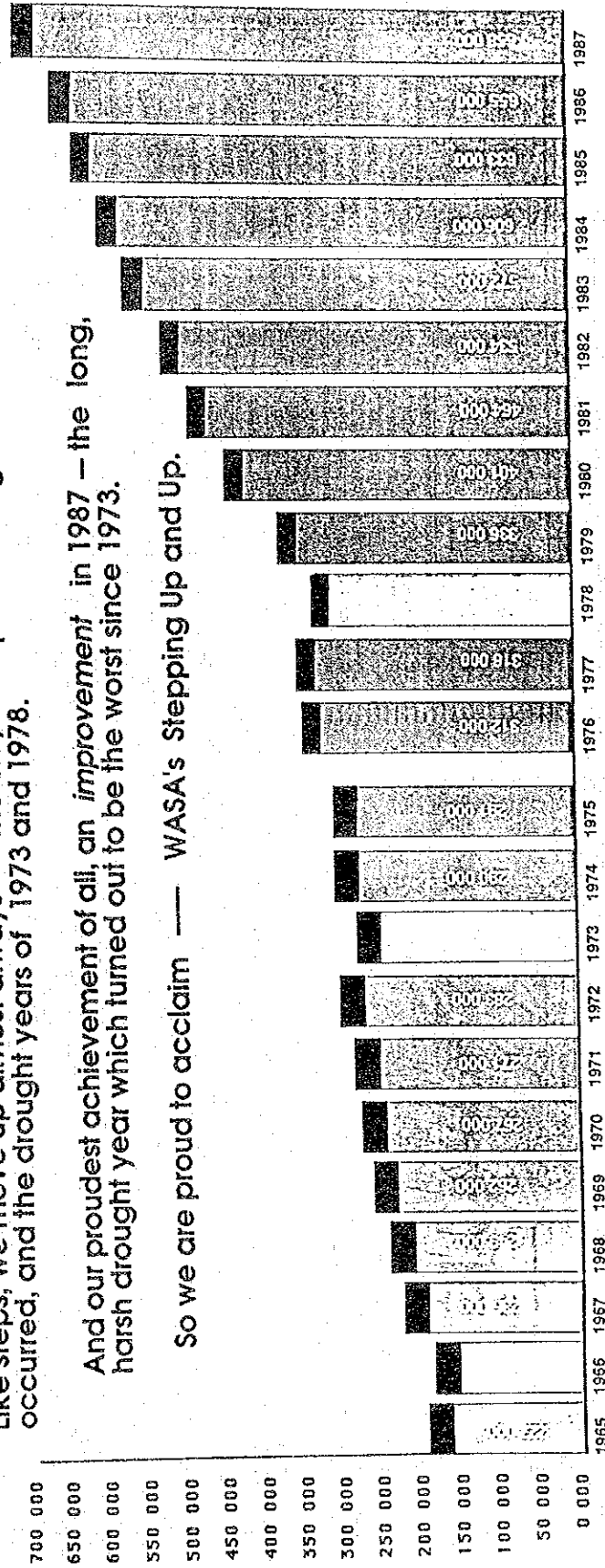


図 4 - 4 年別日平均浄水量の推移(1965—1987)

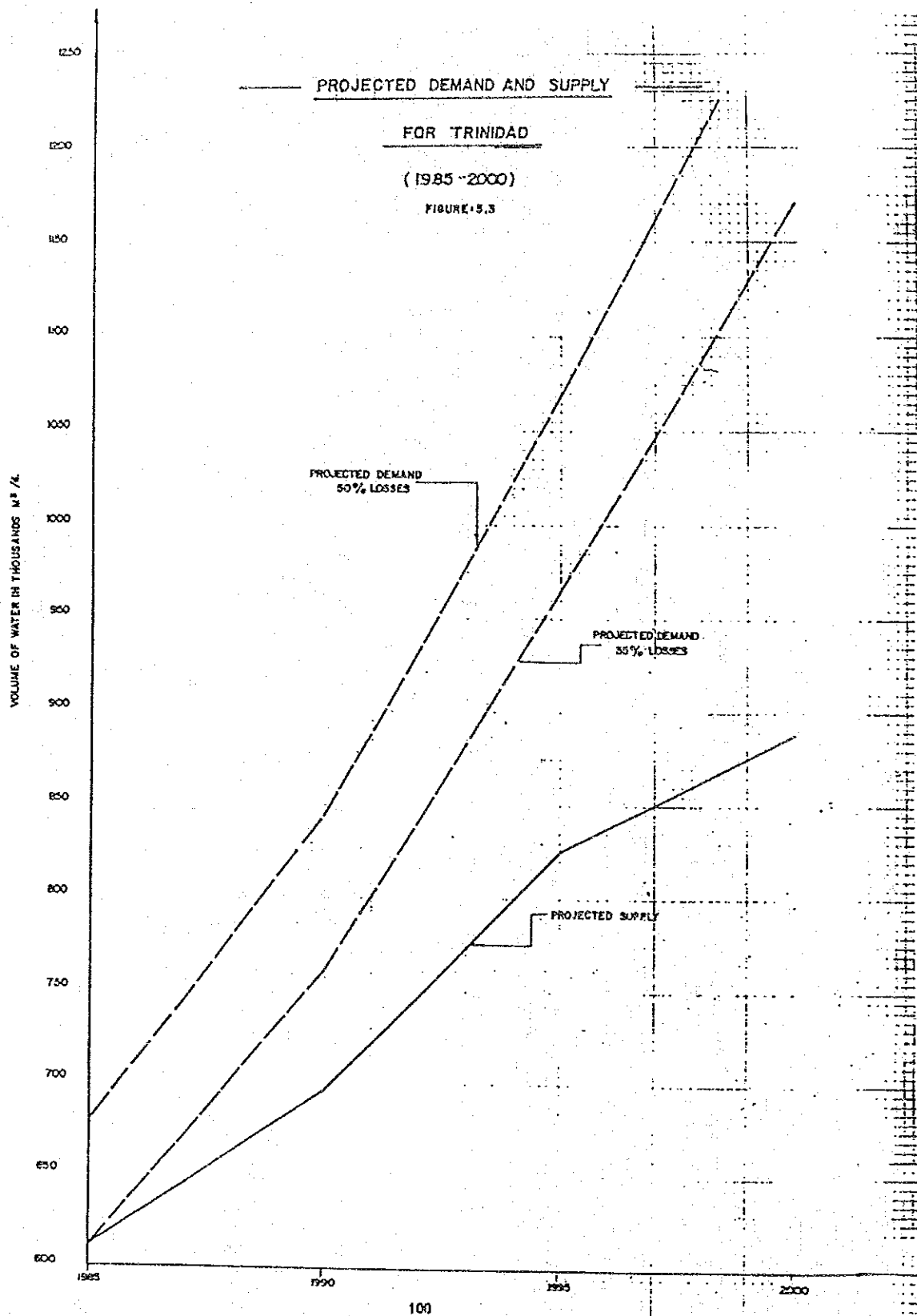


図4-5 トリニダッド島水需給(1985-2000年)

出所: WASA, The Water system balance in Trinidad



**FIGURE 6.1.9.**



出所: WASA, The water system balance in Trinidad 1983年

Figures 3, 4, 5.



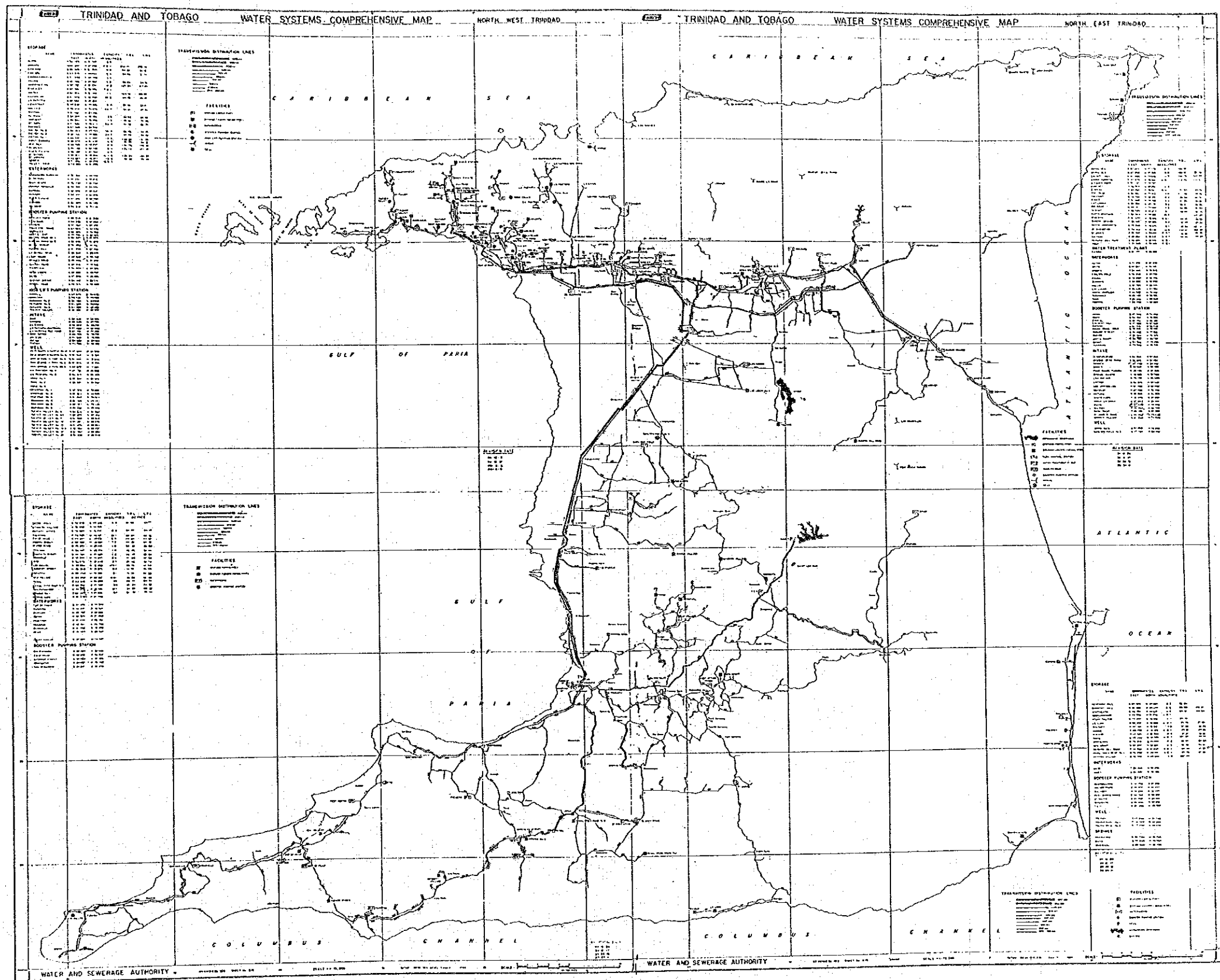


図4-7 トリニダード島水道施設

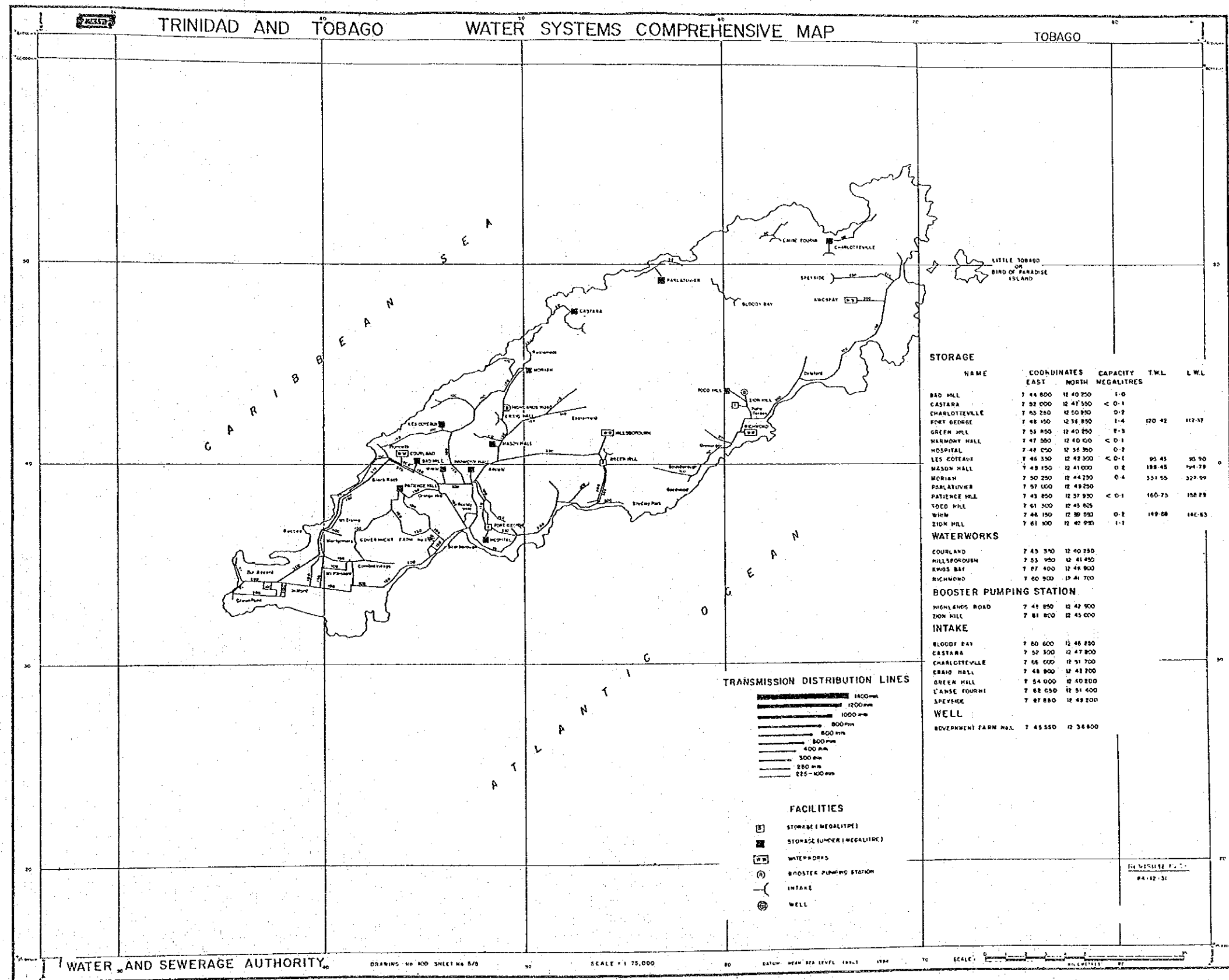


図4-8 トバゴ島水道施設





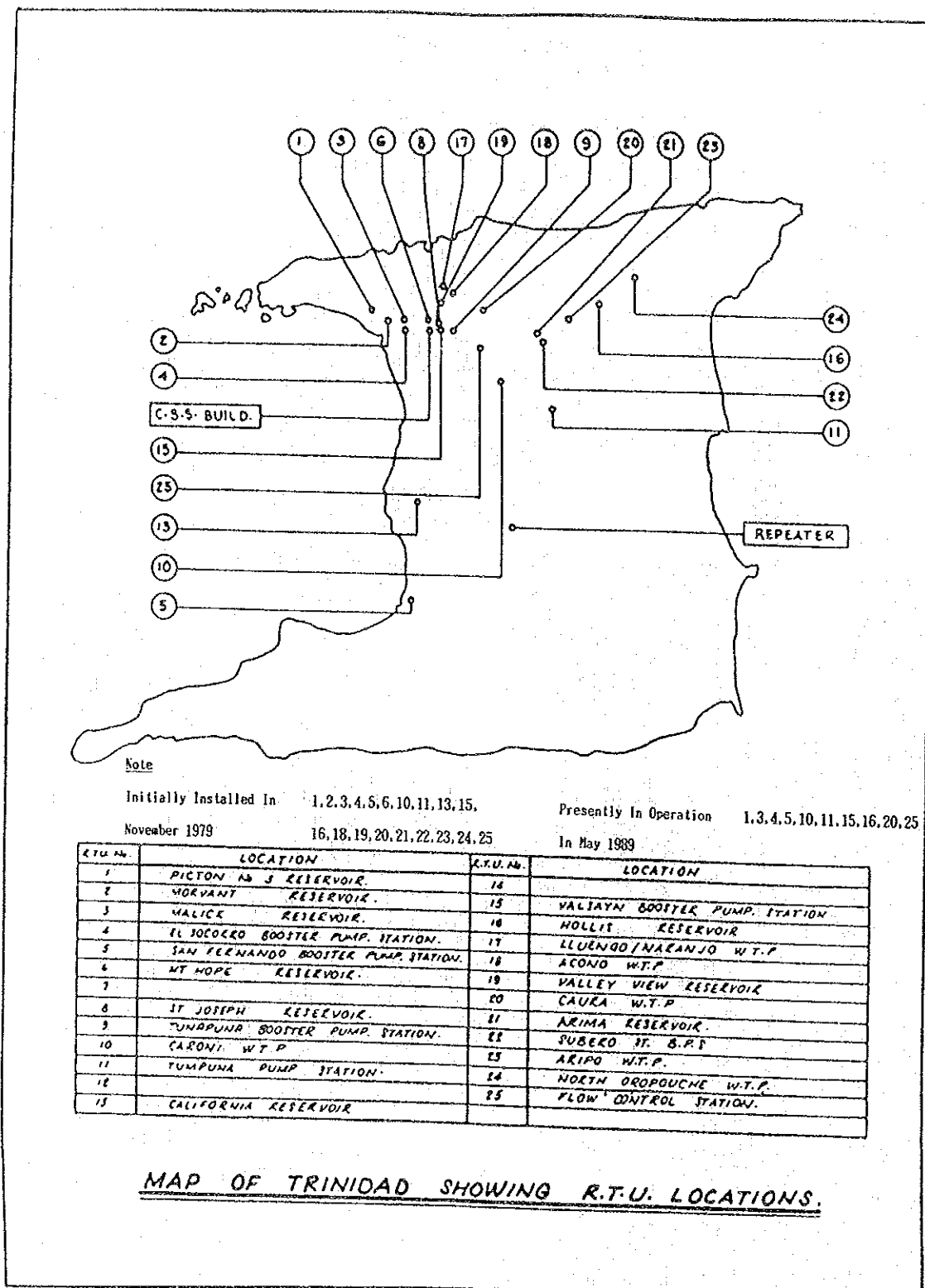


図4-10 RTUの設置箇所位置図

表4-1 WASA職員数 (現状と将来計画)

| Department<br>Unit/<br>Section              | (現在数)<br>Total<br>Existing | (余剰人数)<br>Ex-<br>cess | Total<br>after<br>Phase I<br>(1990年) | Excess<br>after<br>Options<br>Phase II | Total<br>after<br>Phases<br>I & II<br>(1991年) |
|---------------------------------------------|----------------------------|-----------------------|--------------------------------------|----------------------------------------|-----------------------------------------------|
| Operations &<br>Maintenance                 | 2593                       | 349                   | 2244                                 | 464                                    | 1780                                          |
| Wastewater                                  | 303                        | 24                    | 279                                  | 52                                     | 227                                           |
| Quality Control                             | 37                         | -                     | 37                                   | -                                      | 41                                            |
| Water Resources<br>Agency                   | 83                         | -                     | 83                                   | 12                                     | 71                                            |
| Internal Audit                              | 16                         | -                     | 16                                   | -                                      | 16                                            |
| Directorate                                 | 10                         | -                     | 10                                   | -                                      | 11                                            |
| Secretariat                                 | 2                          | -                     | 2                                    | -                                      | 2                                             |
| Personnel                                   | 120                        | 24                    | 96                                   | 19                                     | 77                                            |
| Legal                                       | 4                          | -                     | 4                                    | -                                      | 5                                             |
| Safety                                      | 1                          | -                     | 1                                    | -                                      | 4                                             |
| Stores & Supplies                           | 123                        | 32                    | 91                                   | 16                                     | 75                                            |
| Commercial                                  | 130                        | 19                    | 111                                  | -                                      | 111                                           |
| Expenditure                                 | 93                         | 20                    | 73                                   | 28                                     | 45                                            |
| Costing                                     | 17                         | 11                    | 6                                    | 6                                      | -                                             |
| E.D.P.                                      | 22                         | -                     | 22                                   | -                                      | 22                                            |
| Major Maintenance                           | 203                        | 54                    | 149                                  | 70                                     | 79                                            |
| Planning                                    | 3                          | -                     | 6                                    | -                                      | 6                                             |
| Public Relations                            | 19                         | -                     | 19                                   | -                                      | 8                                             |
| Engineering Admin.                          | 13                         | 1                     | 13                                   | -                                      | 13                                            |
| Budget                                      | 19                         | 8                     | 11                                   | 2                                      | 9                                             |
| Security                                    | 178                        | -                     | 178                                  | -                                      | 178                                           |
| Invest. & Design                            | 69                         | 15                    | 54                                   | 12                                     | 42                                            |
| Registry                                    | 15                         | -                     | 15                                   | -                                      | 15                                            |
| Major Projects                              | 9                          | 4                     | 5                                    | -                                      | 5                                             |
| Transport                                   | 402                        | 107                   | 295                                  | 255                                    | 40                                            |
| Office Services &<br>Property M'tce         | 54                         | -                     | 52                                   | 22                                     | 30                                            |
| Construction                                | 198                        | 134                   | 64                                   | -                                      | 54*                                           |
| Board & Committees                          | 3                          | -                     | 3                                    | -                                      | 4                                             |
| (Unestablished Posts)<br>Operations & M'tce | 224                        | 224                   | -                                    | -                                      | -                                             |
| TOTAL                                       | 4963                       | 1026                  | 3939                                 | 958                                    | 2880                                          |

\* 10 already redeployed to Tobago for maintenance work.  
(Construction work to be carried out as and when required.)

出典 Report On Self Sufficient WASA-1991



表4-2 WASA予算推移(収入及び支出)(1987~1989年)

## SUMMARY OF INCOME AND EXPENDITURE (収入・支出)

| Sub-head Item No. | Description                              | 1987 Actual | 1988 Estimates | 1988 Revised Estimates | 1989 Estimates |
|-------------------|------------------------------------------|-------------|----------------|------------------------|----------------|
|                   |                                          | \$          | \$             | \$                     | \$             |
|                   | Income ... ..                            | 110,082,832 | 143,800,355    | 134,086,055            | 143,800,355    |
|                   | Expenditure ... ..                       | 281,120,059 | 261,126,174    | 232,894,293            | 234,890,355    |
|                   | Operating Deficit ... ..                 | 171,057,227 | 117,235,819    | 98,808,237             | 91,000,000     |
|                   | Depreciation ... ..                      | 36,276,187  | 31,000,000     | 36,000,000             | 36,000,000     |
|                   | Cash Deficit ... ..                      | 134,781,060 | 86,235,819     | 62,808,237             | 55,000,000     |
|                   | Government Loan ... ..                   | 134,208,353 | 86,235,819     | 62,808,237             | 55,000,000     |
|                   | (Unfinanced Deficit)/Cash Surplus ... .. | (672,707)   | —              | —                      | —              |

表4-3 WASAの予算推移(支出内訳)(1987~1989)

## SUMMARY OF EXPENDITURE (支出内訳)

| Description                                                | 1987 Actual Expenditure | 1988 Estimates | 1988 Revised Estimates | 1989 Estimates | 1989 Revised |
|------------------------------------------------------------|-------------------------|----------------|------------------------|----------------|--------------|
|                                                            | \$                      | \$             | \$                     | \$             | \$           |
| Personnel Expenditure ... ..                               | 163,671,607             | 150,744,205    | 130,902,636            | 127,276,540    | 115,776,540  |
| Salaries and Cost of Living Allowances ... ..              | 81,535,404              | 75,741,305     | 68,107,175             | 62,947,115     | 61,367,175   |
| Wages and Cost of Living Allowances ... ..                 | 60,883,649              | 62,239,256     | 47,015,330             | 47,015,330     | 42,315,330   |
| Overtime ... ..                                            | 14,391,951              | 15,404,686     | 9,381,500              | 5,755,464      | 5,755,464    |
| Allowances ... ..                                          | 3,563,624               | 3,588,700      | 3,070,400              | 3,070,400      | 3,070,400    |
| Contribution to National Insurance Scheme ... ..           | 3,200,079               | 3,770,248      | 3,220,685              | 3,220,685      | 3,220,685    |
| Remuneration to Board Members ... ..                       | —                       | —              | 47,486                 | 47,486         | 47,486       |
| Vacant Posts—Salaries and Cost of Living Allowances ... .. | —                       | —              | —                      | 15,220,059     | —            |
| Goods and Services ... ..                                  | 70,619,300              | 66,624,120     | 54,996,947             | 60,659,891     | 60,659,891   |
| Minor Equipment Purchases ... ..                           | 715,189                 | 1,596,320      | 611,341                | 700,000        | 700,000      |
| Current Transfers and Subsidies ... ..                     | 46,113,963              | 42,161,529     | 46,383,369             | 46,253,924     | 46,253,924   |
| TOTAL ... ..                                               | 281,120,059             | 261,120,174    | 232,894,293            | 234,890,355    | 223,390,355  |

出所: WASA

表4-4 1989年收入予算内訳(概算)

ESTIMATES—1989

INCOME

| Description                                                                       | Trinidad           | Tobago           | Total              |
|-----------------------------------------------------------------------------------|--------------------|------------------|--------------------|
|                                                                                   | \$                 | \$               | \$                 |
| <b>Water Income</b>                                                               |                    |                  |                    |
| Metered Supplies ... ..                                                           | —                  | —                | —                  |
| Unmetered Supplies (A.T.V.) ... ..                                                | 108,635,082        | 3,640,391        | 112,284,453        |
| Other Water Income (Bulk Sales to Federation Chemicals, Trinidad Cement, etc) ... | 18,066,763         | —                | 18,066,763         |
| <b>TOTAL WATER INCOME ... ..</b>                                                  | <b>126,701,825</b> | <b>3,640,391</b> | <b>130,361,216</b> |
| <b>Sewerage Income</b>                                                            |                    |                  |                    |
| Interest Sewerage Connection ... ..                                               | 34,650             | —                | 34,650             |
| Sewerage Rates ... ..                                                             | 13,456,478         | —                | 13,456,478         |
| Other Sewerage Income—Sale of Effluent to Trintec, Point-a-Pierre ... ..          | 20,000             | —                | 20,000             |
| Other Sewerage Income—(Disposal of Faecal Matter) ... ..                          | 28,011             | —                | 28,011             |
| <b>TOTAL SEWERAGE INCOME ... ..</b>                                               | <b>13,639,139</b>  | <b>—</b>         | <b>13,639,139</b>  |
| <b>GRAND TOTAL ... ..</b>                                                         | <b>140,240,964</b> | <b>3,640,391</b> | <b>143,890,355</b> |

表 4-5 トリニダード島給水区域

WATER SERVICES AREAS

1. Carenage/Diego Martin
2. Port of Spain and Suburbs
3. Eastern Main Road and adjacent areas from Port of Spain to Arima
4. Arima and adjacent areas North and East of Arima
5. Sangre Grande/Manzanilla/Tamana
6. Waller Field/O'Meara/San Raphael/Talparo/Las Lomas
7. Toco
8. Caroni/Montserrat
9. Mayaro
10. Rio Claro/Princes Town/Moruga/Penal/Fyzabad
11. San Fernando
12. Siparia/Erin
13. La Brea/Point Fortin/Cedros
14. North Coast

表4-6 トリニダード島給水地域別人口 (1980~2000年)

## POPULATION PROJECTIONS BY WATER AREAS

(単位:人)

| Water Area        | Population<br>Census<br>1980 | Annual<br>Rate Of<br>Growth<br>Over 10<br>Yrs. (%) | POPULATION |           | Annual<br>Rate Of<br>Growth<br>Over 10<br>Yrs. (%) | POPULATION |           |
|-------------------|------------------------------|----------------------------------------------------|------------|-----------|----------------------------------------------------|------------|-----------|
|                   |                              |                                                    | 1985       | 1990      |                                                    | 1995       | 2000      |
| 1. Diego Martin   | 62,155                       | 3.0                                                | 71,478     | 80,801    | 2.0                                                | 88,881     | 96,961    |
| 2. Port of Spain  | 89,664                       | 1.8/-1.3                                           | 89,221     | 88,778    | 1.5/-1.2                                           | 88,986     | 89,195    |
| 3-1 St. Barbs     | 6,421                        | 1.9                                                | 7,031      | 7,641     | 1.9                                                | 8,367      | 9,093     |
| -2 Laventille     | 6,408                        | 1.9                                                | 7,017      | 7,626     | 1.9                                                | 8,350      | 9,075     |
| -3 Morvant        | 18,904                       | 1.9                                                | 20,700     | 22,496    | 1.9                                                | 24,633     | 26,770    |
| -4 Picton         | 26,889                       | 1.9                                                | 29,443     | 31,998    | 1.9                                                | 35,038     | 38,078    |
| -5 Barataria      | 32,603                       | 1.9                                                | 35,700     | 38,798    | 1.9                                                | 42,484     | 46,170    |
| -6 St. Joseph     | 29,262                       | 2.0                                                | 32,188     | 35,114    | 2.0                                                | 38,625     | 42,137    |
| -7 Arouca         | 15,943                       | 2.0                                                | 17,537     | 19,132    | 2.0                                                | 21,045     | 22,958    |
| -8 Tacarigua      | 16,289                       | 2.0                                                | 17,918     | 19,547    | 2.0                                                | 21,502     | 23,456    |
| -9 Saddle Road    | 53,351                       | 2.0                                                | 58,686     | 64,021    | 2.0                                                | 70,423     | 76,825    |
| -10 St. Augustine | 18,976                       | 2.0                                                | 20,874     | 22,771    | 2.0                                                | 25,048     | 27,325    |
| -11 Tunapuna      | 21,636                       | 2.0                                                | 23,800     | 25,963    | 2.0                                                | 28,559     | 31,156    |
| 4. Arima          | 36,869                       | 5.2/-0.3                                           | 43,322     | 49,776    | 5.0/-0.3                                           | 59,292     | 68,809    |
| 5. Sangre Grande  | 43,565                       | 1.4                                                | 46,615     | 49,664    | 1.4                                                | 53,140     | 56,617    |
| 6. Wallerfield    | 18,673                       | 5.2                                                | 23,528     | 28,383    | 5.0                                                | 35,479     | 42,575    |
| 7. Toco           | 6,569                        | -1.5                                               | 6,076      | 5,584     | -1.5                                               | 5,165      | 4,746     |
| 8-1 Caroni        | 6,690                        | 3.3                                                | 7,794      | 8,898     | 3.0                                                | 10,233     | 11,567    |
| -2 Cunupia        | 43,103                       | 3.3                                                | 50,215     | 57,327    | 3.0                                                | 65,926     | 74,525    |
| -3 Chaguanas      | 50,291                       | 2.7                                                | 57,080     | 63,870    | 2.5                                                | 71,854     | 79,838    |
| -4 Couva          | 50,472                       | 2.7                                                | 57,286     | 64,099    | 5.0                                                | 80,124     | 96,149    |
| 9. Mayaro         | 9,621                        | 1.0                                                | 10,102     | 10,583    | 1.0                                                | 11,112     | 11,641    |
| 10-1 Arch Trace   | 45,896                       | 1.2                                                | 48,650     | 51,404    | 1.2                                                | 54,488     | 57,572    |
| -2 Princes Town   | 43,102                       | 1.8                                                | 46,981     | 50,860    | 1.7                                                | 55,183     | 59,506    |
| -3 Barrackpore    | 44,096                       | 1.7                                                | 47,822     | 51,569    | 1.6                                                | 55,694     | 59,820    |
| -4 Fyzabad        | 51,595                       | 2.0                                                | 56,755     | 61,914    | 2.0                                                | 68,105     | 74,297    |
| -5 Palmyra        | 39,306                       | 2.0                                                | 43,237     | 47,167    | 2.0                                                | 51,884     | 56,600    |
| -6 Marabella      | 18,158                       | 3.2                                                | 21,063     | 23,969    | 3.0                                                | 27,564     | 31,160    |
| 11. San Fernando  | 33,490                       | -1.0                                               | 31,816     | 30,141    | -1.0                                               | 28,634     | 27,127    |
| 12. Siparia/Erin  | 29,537                       | 1.0                                                | 31,014     | 32,491    | 1.0                                                | 34,115     | 35,740    |
| 13. Point Fortin  | 44,113                       | 0.1                                                | 44,334     | 44,554    | 0.2                                                | 45,000     | 45,445    |
| 14. North Coast   | 1,669                        | 0.3                                                | 1,694      | 1,719     | 0.3                                                | 1,745      | 1,771     |
| TOTAL             | 1,015,296                    | 1.80                                               | 1,106,977  | 1,198,658 | 1.97                                               | 1,316,678  | 1,434,704 |

表 4-7 トリニダード島給水地域別給水形態別人口

POPULATION PROJECTIONS BY SERVICE TYPE CONNECTIONS IN EACH WATER AREA

| WATER AREA         | 1980           |                |                | 1985           |                |                | 1990           |                |                | 1995           |                |                | 2000           |                |                |
|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                    | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> |
| 1. Diego Martin    | 35,242         | 4,537          | 16,223         | 42,887         | 8,577          | 14,296         | 52,521         | 12,120         | 12,120         | 63,945         | 15,999         | 6,222          | 72,721         | 19,392         | 4,818          |
| 2. Port of Spain   | 58,843         | 12,711         | 14,540         | 60,670         | 14,275         | 11,599         | 63,032         | 15,980         | 7,990          | 67,629         | 17,797         | 2,670          | 69,572         | 10,731         | 892            |
| 3.1 St. Barbara    | 3,320          | 841            | 1,914          | 3,867          | 1,266          | 1,617          | 4,595          | 1,605          | 1,299          | 5,606          | 1,924          | 753            | 6,365          | 2,273          | 455            |
| 3.2 Laventille     | 3,313          | 839            | 1,910          | 3,859          | 1,263          | 1,614          | 4,576          | 1,601          | 1,296          | 5,595          | 1,920          | 752            | 6,352          | 2,269          | 454            |
| 3.3 Morvant        | 9,773          | 2,476          | 5,633          | 11,385         | 3,726          | 4,761          | 13,498         | 4,724          | 3,824          | 16,504         | 5,666          | 2,217          | 10,739         | 6,692          | 1,339          |
| 3.4 Pictou         | 13,902         | 3,522          | 8,013          | 16,194         | 5,300          | 6,772          | 19,199         | 6,720          | 5,440          | 23,475         | 8,059          | 3,153          | 26,854         | 9,520          | 1,904          |
| 3.5 Bartlett       | 16,956         | 4,271          | 9,716          | 19,635         | 6,426          | 8,211          | 23,279         | 8,148          | 6,596          | 28,464         | 9,771          | 3,824          | 32,319         | 11,542         | 2,307          |
| 3.6 St. Joseph     | 17,555         | 5,353          | 5,046          | 20,278         | 7,081          | 3,863          | 23,526         | 8,778          | 2,282          | 27,038         | 10,429         | 773            | 30,339         | 11,377         | 421            |
| 3.7 Arouca         | 9,274          | 3,079          | 2,801          | 10,873         | 4,034          | 2,104          | 12,627         | 4,783          | 1,339          | 14,732         | 5,682          | 421            | 16,530         | 6,199          | 229            |
| 3.8 Tacarigua      | 10,164         | 3,225          | 2,215          | 11,647         | 4,121          | 1,613          | 13,487         | 4,887          | 782            | 15,481         | 5,590          | 215            | 17,240         | 6,099          | 117            |
| 3.9 Saddle Road    | 27,582         | 6,909          | 15,899         | 32,277         | 10,563         | 13,498         | 38,413         | 13,444         | 10,884         | 47,183         | 16,197         | 6,338          | 53,770         | 19,206         | 3,841          |
| 3.10 St. Augustine | 11,841         | 3,757          | 2,581          | 13,568         | 4,801          | 1,879          | 15,712         | 5,693          | 911            | 18,034         | 6,512          | 250            | 20,084         | 7,104          | 137            |
| 3.11 Tunapuna      | 13,501         | 4,284          | 2,942          | 15,470         | 5,474          | 2,142          | 17,914         | 6,491          | 1,039          | 20,562         | 7,425          | 286            | 22,900         | 8,100          | 156            |
| 4. Arima           | 19,452         | 6,281          | 9,179          | 25,993         | 9,096          | 6,715          | 33,350         | 10,453         | 4,978          | 42,690         | 13,844         | 2,965          | 51,607         | 15,026         | 1,376          |
| 5. Sangre Grande   | 15,846         | 6,081          | 17,940         | 18,646         | 9,323          | 15,849         | 22,349         | 11,919         | 13,409         | 27,633         | 13,816         | 10,628         | 31,135         | 15,853         | 9,625          |
| 6. Waller Field    | 6,324          | 4,296          | 6,531          | 9,411          | 5,647          | 7,058          | 13,340         | 7,380          | 6,528          | 19,513         | 9,934          | 5,322          | 25,545         | 12,773         | 4,257          |
| 7. Toco            | 1,846          | 723            | 3,377          | 2,127          | 911            | 2,734          | 2,234          | 949            | 2,234          | 2,583          | 1,033          | 1,446          | 2,610          | 1,187          | 949            |
| 8.1 Caroni         | 2,886          | 1,702          | 1,766          | 3,741          | 2,338          | 1,481          | 4,716          | 2,847          | 1,157          | 6,140          | 3,582          | 409            | 7,172          | 4,164          | 231            |
| 8.2 Cunupia        | 14,835         | 11,516         | 13,634         | 18,580         | 15,567         | 13,558         | 24,077         | 18,978         | 12,512         | 36,963         | 23,074         | 8,570          | 40,989         | 27,574         | 5,962          |
| 8.3 Chaguanas      | 17,838         | 13,650         | 15,524         | 22,832         | 18,265         | 13,414         | 28,742         | 22,355         | 10,858         | 39,520         | 27,305         | 3,593          | 47,104         | 30,339         | 2,395          |
| 8.4 Couva          | 18,481         | 13,093         | 16,437         | 24,633         | 16,613         | 14,322         | 32,050         | 20,512         | 10,256         | 48,074         | 27,242         | 4,006          | 60,574         | 32,691         | 2,884          |
| 9. Mayaro          | 2,946          | 1,033          | 5,112          | 3,435          | 1,212          | 5,051          | 4,233          | 1,587          | 4,445          | 5,556          | 2,000          | 3,334          | 6,403          | 2,328          | 2,910          |
| 10.1 Arch Truce    | 12,239         | 5,462          | 22,220         | 14,595         | 7,298          | 21,893         | 17,991         | 9,253          | 20,048         | 28,520         | 10,898         | 16,386         | 31,665         | 14,393         | 11,514         |
| 10.2 Princes Town  | 14,407         | 5,996          | 20,076         | 17,383         | 6,457          | 18,792         | 21,870         | 10,681         | 16,784         | 30,351         | 13,796         | 9,933          | 35,704         | 17,852         | 5,950          |
| 10.3 Barrackpore   | 15,954         | 6,549          | 18,411         | 19,129         | 9,584          | 16,738         | 23,722         | 11,861         | 14,439         | 30,632         | 13,924         | 10,025         | 35,892         | 17,946         | 5,982          |
| 10.4 Fyzabad       | 23,822         | 8,709          | 16,393         | 28,378         | 12,486         | 14,189         | 35,291         | 15,479         | 9,006          | 44,268         | 19,069         | 4,086          | 50,522         | 21,546         | 2,229          |
| 10.5 Palmyra       | 18,241         | 7,195          | 12,437         | 22,051         | 9,512          | 10,809         | 27,357         | 11,320         | 8,018          | 34,762         | 13,960         | 3,372          | 39,054         | 15,282         | 2,264          |
| 10.6 Marabella     | 9,624          | 3,359          | 4,594          | 12,217         | 4,213          | 4,213          | 15,580         | 5,273          | 2,876          | 19,446         | 6,064          | 1,516          | 23,370         | 7,167          | 623            |
| 11. San Fernando   | 30,777         | 1,607          | 871            | 29,589         | 1,654          | 477            | 28,332         | 1,658          | 90             | 26,973         | 1,603          | 28             | 25,600         | 1,509          | 10             |
| 12. Siparia/Erin   | 8,847          | 3,809          | 14,507         | 10,595         | 5,272          | 13,336         | 12,996         | 6,498          | 11,697         | 17,058         | 7,846          | 8,529          | 19,657         | 8,935          | 7,148          |
| 13. Point Fortin   | 18,151         | 6,004          | 18,237         | 19,950         | 7,537          | 15,739         | 22,277         | 8,911          | 12,698         | 27,000         | 10,550         | 7,200          | 29,539         | 11,362         | 4,544          |
| 14. North Coast    | 130            | 57             | 1,017          | 237            | 271            | 847            | 374            | 344            | 705            | 611            | 524            | 436            | 797            | 620            | 354            |
| TOTAL              | 483,612        | 163,120        | 307,896        | 566,082        | 222,145        | 271,184        | 673,254        | 273,172        | 219,540        | 834,990        | 331,565        | 129,618        | 958,544        | 387,851        | 88,309         |

表4-8 トリニダード島給水区域別給水形態別割合 (1980~2000年)

PERCENTAGE OF POPULATION BY SERVICE TYPE CONNECTIONS IN EACH WATER AREA

(単位: %)

| WATER AREA         | 1980           |                |                |                | 1985           |                |                |                | 1990           |                |                |                | 1995           |                |                |                | 2000           |                |                |                |
|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                    | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>4</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>4</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>4</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>4</sub> | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | A <sub>4</sub> |
|                    | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              | u              |
| 1. Diego Martin    | 56.7           | 7.3            | 26.1           | 9.9            | 60.0           | 12.0           | 20.0           | 8.0            | 65.0           | 15.0           | 15.0           | 5.0            | 72.0           | 18.0           | 7.0            | 3.0            | 75.0           | 20.0           | 5.0            | 0              |
| 2. Port of Spain   | 65.6           | 14.2           | 16.2           | 4.0            | 68.0           | 16.0           | 13.0           | 3.0            | 71.0           | 18.0           | 9.0            | 2.0            | 76.0           | 20.0           | 3.0            | 1.0            | 78.0           | 21.0           | 1.0            | 0              |
| 3.1 St. George     | 51.7           | 13.1           | 29.8           | 5.4            | 55.0           | 18.0           | 23.0           | 4.0            | 60.0           | 21.0           | 17.0           | 2.0            | 67.0           | 23.0           | 9.0            | 1.0            | 70.0           | 25.0           | 5.0            | 0              |
| 3.2 Laventille     | 51.7           | 13.1           | 29.8           | 5.4            | 55.0           | 18.0           | 23.0           | 4.0            | 60.0           | 21.0           | 17.0           | 2.0            | 67.0           | 23.0           | 9.0            | 1.0            | 70.0           | 25.0           | 5.0            | 0              |
| 3.3 Morvant        | 51.7           | 13.1           | 29.8           | 5.4            | 55.0           | 18.0           | 23.0           | 4.0            | 60.0           | 21.0           | 17.0           | 2.0            | 67.0           | 23.0           | 9.0            | 1.0            | 70.0           | 25.0           | 5.0            | 0              |
| 3.4 Pictou         | 51.7           | 13.1           | 29.8           | 5.4            | 55.0           | 18.0           | 23.0           | 4.0            | 60.0           | 21.0           | 17.0           | 2.0            | 67.0           | 23.0           | 9.0            | 1.0            | 70.0           | 25.0           | 5.0            | 0              |
| 3.5 Barataria      | 51.7           | 13.1           | 29.8           | 5.4            | 55.0           | 18.0           | 23.0           | 4.0            | 60.0           | 21.0           | 17.0           | 2.0            | 67.0           | 23.0           | 9.0            | 1.0            | 70.0           | 25.0           | 5.0            | 0              |
| 3.6 St. Joseph     | 60.0           | 18.3           | 17.2           | 4.5            | 63.0           | 22.0           | 12.0           | 3.0            | 67.0           | 25.0           | 6.5            | 1.5            | 70.0           | 27.0           | 2.0            | 1.0            | 72.0           | 27.0           | 1.0            | 0              |
| 3.7 Arouca         | 58.2           | 19.3           | 17.6           | 4.9            | 62.0           | 23.0           | 12.0           | 3.0            | 66.0           | 25.0           | 7.0            | 2.0            | 70.0           | 27.0           | 2.0            | 1.0            | 72.0           | 27.0           | 1.0            | 0              |
| 3.8 Tacarigua      | 62.4           | 19.8           | 13.6           | 4.2            | 65.0           | 23.0           | 9.0            | 3.0            | 69.0           | 25.0           | 4.0            | 2.0            | 72.0           | 26.0           | 1.0            | 1.0            | 73.5           | 26.0           | 0.5            | 0              |
| 3.9 Saddle Road    | 51.7           | 13.1           | 29.8           | 5.4            | 55.0           | 18.0           | 23.0           | 4.0            | 60.0           | 21.0           | 17.0           | 2.0            | 67.0           | 23.0           | 9.0            | 1.0            | 70.0           | 25.0           | 5.0            | 0              |
| 3.10 St. Augustine | 62.4           | 19.8           | 13.6           | 4.2            | 65.0           | 23.0           | 9.0            | 3.0            | 69.0           | 25.0           | 4.0            | 2.0            | 72.0           | 26.0           | 1.0            | 1.0            | 73.5           | 26.0           | 0.5            | 0              |
| 3.11 Tunapuna      | 62.4           | 19.8           | 13.6           | 4.2            | 65.0           | 23.0           | 9.0            | 3.0            | 69.0           | 25.0           | 4.0            | 2.0            | 72.0           | 26.0           | 1.0            | 1.0            | 73.5           | 26.0           | 0.5            | 0              |
| 4. Arima           | 52.8           | 17.0           | 24.9           | 5.3            | 60.0           | 21.0           | 15.0           | 3.5            | 67.0           | 21.0           | 10.0           | 2.0            | 72.0           | 22.0           | 5.0            | 1.0            | 75.0           | 23.0           | 2.0            | 0              |
| 5. Sangre Grande   | 35.9           | 14.0           | 41.2           | 8.9            | 40.0           | 20.0           | 34.0           | 6.0            | 45.0           | 24.0           | 27.0           | 4.0            | 52.0           | 26.0           | 20.0           | 2.0            | 55.0           | 20.0           | 17.0           | 0              |
| 6. Waller Field    | 33.9           | 22.0           | 35.0           | 8.3            | 40.0           | 24.0           | 30.0           | 6.0            | 47.0           | 26.0           | 23.0           | 4.0            | 55.0           | 28.0           | 15.0           | 2.0            | 60.0           | 30.0           | 10.0           | 0              |
| 7. Toco            | 28.1           | 11.0           | 51.4           | 9.5            | 35.0           | 15.0           | 45.0           | 5.0            | 40.0           | 17.0           | 40.0           | 3.0            | 50.0           | 20.0           | 28.0           | 2.0            | 55.0           | 25.0           | 20.0           | 0              |
| 8.1 Caroni         | 43.2           | 25.4           | 26.4           | 5.0            | 48.0           | 30.0           | 19.0           | 3.0            | 53.0           | 32.0           | 13.0           | 2.0            | 60.0           | 35.0           | 4.0            | 1.0            | 62.0           | 36.0           | 2.0            | 0              |
| 8.2 Cumupia        | 34.4           | 26.7           | 32.1           | 6.8            | 37.0           | 31.0           | 27.0           | 5.0            | 42.0           | 33.0           | 22.0           | 3.0            | 50.0           | 35.0           | 13.0           | 2.0            | 55.0           | 37.0           | 8.0            | 0              |
| 8.3 Chaguana       | 35.5           | 27.1           | 30.9           | 6.5            | 40.0           | 32.0           | 23.5           | 4.5            | 45.0           | 35.0           | 17.0           | 3.0            | 55.0           | 38.0           | 5.0            | 2.0            | 59.0           | 38.0           | 3.0            | 0              |
| 8.4 Couva          | 36.6           | 25.9           | 32.6           | 4.9            | 43.0           | 29.0           | 25.0           | 3.0            | 50.0           | 32.0           | 16.0           | 2.0            | 60.0           | 34.0           | 5.0            | 1.0            | 63.0           | 34.0           | 3.0            | 0              |
| 9. Mayaro          | 30.6           | 10.7           | 53.2           | 5.5            | 34.0           | 12.0           | 50.0           | 4.0            | 40.0           | 15.0           | 42.0           | 3.0            | 50.0           | 18.0           | 30.0           | 2.0            | 55.0           | 20.0           | 25.0           | 0              |
| 10.1 Arch Traco    | 26.7           | 11.9           | 48.4           | 13.0           | 30.0           | 15.0           | 45.0           | 10.0           | 35.0           | 18.0           | 39.0           | 8.0            | 45.0           | 20.0           | 30.0           | 5.0            | 55.0           | 25.0           | 20.0           | 0              |
| 10.2 Princes Town  | 33.4           | 13.9           | 46.6           | 6.1            | 37.0           | 18.0           | 40.0           | 5.0            | 43.0           | 21.0           | 33.0           | 3.0            | 55.0           | 25.0           | 18.0           | 2.0            | 60.0           | 30.0           | 10.0           | 0              |
| 10.3 Barrackpore   | 36.2           | 14.9           | 41.8           | 7.1            | 40.0           | 20.0           | 35.0           | 5.0            | 46.0           | 23.0           | 28.0           | 3.0            | 55.0           | 25.0           | 18.0           | 2.0            | 60.0           | 30.0           | 10.0           | 0              |
| 10.4 Fyzabad       | 46.2           | 17.0           | 31.6           | 5.0            | 50.0           | 22.0           | 25.0           | 3.0            | 57.0           | 25.0           | 16.0           | 2.0            | 65.0           | 28.0           | 6.0            | 1.0            | 68.0           | 29.0           | 3.0            | 0              |
| 10.5 Palmyra       | 46.4           | 18.3           | 31.6           | 3.7            | 51.0           | 22.0           | 25.0           | 2.0            | 58.0           | 24.0           | 17.0           | 1.0            | 67.0           | 26.0           | 6.5            | 0.5            | 69.0           | 27.0           | 4.0            | 0              |
| 10.6 Marabella     | 53.0           | 18.5           | 25.3           | 3.2            | 58.0           | 20.0           | 20.0           | 2.0            | 65.0           | 22.0           | 12.0           | 1.0            | 72.0           | 22.0           | 5.5            | 0.5            | 75.0           | 23.0           | 2.0            | 0              |
| 11. San Fernando   | 91.9           | 4.8            | 2.6            | 0.7            | 93.0           | 5.2            | 1.5            | 0.3            | 94.0           | 5.5            | 0.3            | 0.2            | 94.2           | 5.6            | 0.1            | 0.1            | 94.3           | 5.6            | 0.1            | 0              |
| 12. Siparia/Erin   | 30.0           | 13.2           | 49.1           | 7.7            | 34.0           | 17.0           | 43.0           | 6.0            | 40.0           | 20.0           | 36.0           | 4.0            | 50.0           | 23.0           | 25.0           | 2.0            | 55.0           | 25.0           | 20.0           | 0              |
| 13. Point Fortin   | 41.2           | 13.6           | 41.3           | 3.9            | 45.0           | 17.0           | 35.5           | 2.5            | 50.0           | 20.0           | 28.5           | 1.5            | 60.0           | 23.0           | 16.0           | 1.0            | 65.0           | 25.0           | 10.0           | 0              |
| 14. North Coast    | 7.8            | 3.4            | 60.9           | 27.9           | 14.0           | 16.0           | 50.0           | 20.0           | 22.0           | 20.0           | 41.0           | 17.0           | 35.0           | 30.0           | 25.0           | 10.0           | 45.0           | 35.0           | 20.0           | 0              |
| TOTAL              | 47.6           | 16.1           | 30.3           | 6.0            | 51.1           | 20.1           | 24.5           | 4.3            | 56.2           | 22.8           | 18.3           | 2.7            | 63.4           | 25.2           | 9.6            | 1.6            | 66.8           | 27.0           | 6.2            | 0              |

表4-9 トリニダード島給水形態別割合(%)

PERCENTAGES FOR CONSUMERS BY SERVICE TYPE CONNECTIONS  
IN TRINIDAD

| CONSUMER TYPE                                        | 1980 | 1985 | 1990 | 1995 | 2000 |
|------------------------------------------------------|------|------|------|------|------|
| A <sub>1</sub> - Direct Connection                   | 47.6 | 51.1 | 56.2 | 63.4 | 66.8 |
| A <sub>2</sub> - Yard Tap                            | 16.1 | 20.1 | 22.8 | 25.2 | 27.0 |
| A <sub>3</sub> - Public Standpipe<br>and Truck Borne | 30.3 | 24.5 | 18.3 | 9.8  | 6.2  |
| SUB-TOTAL                                            | 94.0 | 95.7 | 97.3 | 98.4 | 100  |
| A <sub>4</sub> - No water supply                     | 6.0  | 4.3  | 2.7  | 1.6  | 0    |

表4-10 トリニダード島給水形態別人口

POPULATION BY SERVICE TYPE CONNECTIONS

| CONSUMER TYPE                                    | P O P U L A T I O N |           |           |           |           |
|--------------------------------------------------|---------------------|-----------|-----------|-----------|-----------|
|                                                  | 1980                | 1985      | 1990      | 1995      | 2000      |
| A <sub>1</sub> - Direct Connections              | 483,612             | 566,082   | 673,254   | 834,990   | 958,544   |
| A <sub>2</sub> - Yard Tap                        | 163,120             | 222,145   | 273,172   | 331,565   | 387,861   |
| A <sub>3</sub> - Public Standpipe<br>Truck Borne | 307,896             | 271,184   | 219,540   | 129,618   | 88,299    |
| SUB-TOTAL                                        | 954,628             | 1,059,411 | 1,165,966 | 1,296,173 | 1,434,704 |
| A <sub>4</sub> - No Water Supply                 | 60,668              | 47,566    | 32,692    | 20,505    | 0         |
| TOTAL                                            | 1,015,296           | 1,106,977 | 1,198,658 | 1,316,678 | 1,434,704 |

表4-11 トリニダード・トバゴ浄水量の推移 (1965年～1988年)

WATER PRODUCTION BY WASA FOR TRINIDAD AND TOBAGO

| YEAR | TOTAL ANNUAL<br>PRODUCTION<br>( $10^6 \text{ m}^3/\text{yr}$ ) | DAILY AVERAGE<br>PRODUCTION<br>( $\text{m}^3/\text{d}$ ) | DAILY AVERAGE<br>PRODUCTION<br>(MGD) |
|------|----------------------------------------------------------------|----------------------------------------------------------|--------------------------------------|
| 1965 | 79.802                                                         | 218,636                                                  | 48.100                               |
| 1966 | 81.672                                                         | 223,759                                                  | 49.221                               |
| 1967 | 86.142                                                         | 236,006                                                  | 51.915                               |
| 1968 | 91.123                                                         | 248,971                                                  | 54.767                               |
| 1969 | 95.798                                                         | 262,459                                                  | 57.734                               |
| 1970 | 97.386                                                         | 266,809                                                  | 58.691                               |
| 1971 | 98.837                                                         | 270,787                                                  | 59.566                               |
| 1972 | 103.680                                                        | 283,279                                                  | 62.314                               |
| 1973 | 100.341                                                        | 274,906                                                  | 60.472                               |
| 1974 | 105.947                                                        | 290,267                                                  | 63.851                               |
| 1975 | 106.063                                                        | 290,585                                                  | 63.921                               |
| 1976 | 114.346                                                        | 312,419                                                  | 68.725                               |
| 1977 | 116.070                                                        | 318,002                                                  | 69.952                               |
| 1978 | 113.701                                                        | 311,510                                                  | 68.524                               |
| 1979 | 122.710                                                        | 336,195                                                  | 73.954                               |
| 1980 | 146.696                                                        | 400,807                                                  | 88.167                               |
| 1981 | 169.242                                                        | 463,678                                                  | 101.997                              |
| 1982 | 195.030                                                        | 534,330                                                  | 117.538                              |
| 1983 | 208.925                                                        | 572,396                                                  | 125.912                              |
| 1984 | 221.900                                                        | 607,944                                                  | 133.732                              |
| 1985 | 230.913                                                        | 633,000                                                  | 139.243                              |
| 1986 | 239.185                                                        | 655,304                                                  | 144.083                              |
| 1987 | 240.170                                                        | 658,000                                                  | 144.211                              |
| 1988 | 241.103                                                        | 660,556                                                  | 145.305                              |

- 注1. 1984年までの数字は「The Water System Balance in Trinidad」による。  
 2. 1985年以降の数字はWASAの水量年報による。



表 4-12 トリニダード島水源と生産能力(1) (1984~2000年)

EXISTING AND PROJECTED SUPPLY CAPABILITY OF WSA WATER SOURCES (1984 - 2000)

DAILY AVERAGE PRODUCTION (m<sup>3</sup>/d)

| SUPPLY SOURCE                       | PRODUCTION<br>1984 | PRODUCTION<br>CAPACITY | PROJECTED PRODUCTION |        |        |        | REMARKS          |
|-------------------------------------|--------------------|------------------------|----------------------|--------|--------|--------|------------------|
|                                     |                    |                        | 1985                 | 1990   | 1995   | 2000   |                  |
| Tucker Valley and Chaguaramas Wells | 13,248             | 13,640                 | 13,400               | 13,640 | 13,640 | 13,640 |                  |
| Four Roads Wells                    | 28,182             | 28,900                 | 28,500               | 28,900 | 28,900 | 28,900 |                  |
| River Estate Wells                  | 6,763              | 6,820                  | 6,800                | 6,820  | 6,820  | 6,820  |                  |
| Dorrlington Gardens Wells           | 2,609              | 5,400                  | 3,200                | 4,500  | 5,400  | 5,400  |                  |
| Coviana Intake                      | 76                 | 90                     | 80                   | 90     | 90     | 90     |                  |
| Maraval Reservoir                   | 5,502              | 5,910                  | 5,600                | 5,800  | 5,910  | 5,910  |                  |
| St. Ann's Intake                    | 840                | 840                    | 840                  | 840    | 840    | 840    |                  |
| St. Clair Well                      | 1,729              | 1,820                  | 1,750                | 1,820  | 1,820  | 1,820  |                  |
| Savannah Wells                      | 10,051             | 12,270                 | 11,000               | 12,270 | 12,270 | 12,270 |                  |
| King George V Park Wells            | 9,617              | 10,340                 | 10,000               | 10,340 | 10,340 | 10,340 |                  |
| Dibe Intake                         | 110                | 130                    | 120                  | -      | -      | -      | Abandon by 1987. |
| Moka Well                           | 1,306              | 1,590                  | 1,300                | 1,400  | 1,590  | 1,590  |                  |
| Casade Intake                       | 456                | 545                    | 500                  | -      | -      | -      | Abandon by 1987. |
| Arispita Intake                     | 227                | 327                    | 230                  | 300    | 327    | 327    |                  |
| Parrell Pumping Station Wells       | 1,240              | 3,860                  | 1,000                | -      | -      | -      | Abandon by 1987  |
| Parasin Waterworks                  | 446                | 1,178                  | 600                  | 900    | 1,178  | 1,178  |                  |
| Mon Apas Intake                     | 44                 | 90                     | 60                   | 90     | 90     | 90     |                  |
| Arouca Wells                        | 1,571              | 1,860                  | 1,600                | 1,700  | 1,860  | 1,860  |                  |
| Lopinot Intake                      | 36                 | 145                    | 45                   | 80     | 100    | 145    |                  |
| Surrey Intake                       | 18                 | 45                     | 30                   | 45     | 45     | 45     |                  |
| La Pastora Well                     | 1,131              | 2,900                  | 1,400                | 1,900  | 2,400  | 2,900  |                  |
| La Pastora Intake                   | 35                 | -                      | -                    | -      | -      | -      | Abandon by 1985  |
| La Pastora/Capriata                 | 106                | 530                    | -                    | -      | -      | -      | Abandon by 1985  |
| La Canoa Intake                     | 61                 | 200                    | 80                   | 100    | 150    | 200    |                  |
| Pipiol Intake                       | 76                 | 90                     | 80                   | 90     | 90     | 90     |                  |
| St. John's Intake                   | 451                | 451                    | 451                  | 451    | 451    | 451    |                  |
| Aries Well                          | 511                | 3,000                  | 700                  | 1,000  | 2,000  | 3,000  |                  |
| Valencia Intake                     | 3,657              | 6,818                  | 4,000                | 5,000  | 6,000  | 6,818  |                  |
| Biche Waterworks                    | 389                | 400                    | 350                  | 400    | 400    | 400    |                  |

表4-12 トリニダード島水源と生産能力(2) (1984~2000年)

EXISTING AND PROJECTED SUPPLY CAPABILITY OF WSA WATER SOURCES (1984 - 2000)  
DAILY AVERAGE PRODUCTION (m<sup>3</sup>/d)

| SUPPLY SOURCE                      | PRODUCTION<br>1984 | PRODUCTION<br>CAPACITY | PROJECTED PRODUCTION |        |        |        | REMARKS            |
|------------------------------------|--------------------|------------------------|----------------------|--------|--------|--------|--------------------|
|                                    |                    |                        | 1985                 | 1990   | 1995   | 2000   |                    |
| Cumana Intake                      | 11                 | 45                     | 20                   | 45     | 45     | 45     |                    |
| Four Roads-Tamara Intake           | 68                 | 70                     | 65                   | 70     | 70     | 70     |                    |
| Cuicco Tamara/los Aradillos Intake | 90                 | 105                    | 90                   | 100    | 105    | 105    |                    |
| Wallerfield Wells                  | -                  | 4,000                  | -                    | 1,000  | 2,500  | 3,500  |                    |
| Matalet Intake                     | 36                 | 105                    | 45                   | 80     | 105    | 105    |                    |
| Grande Riviere Intake              | 36                 | 45                     | 40                   | 45     | 45     | 45     |                    |
| Salybia Intake                     | 36                 | 45                     | 40                   | 45     | 45     | 45     |                    |
| Montevideo                         | 36                 | 45                     | 40                   | 45     | 45     | 45     |                    |
| Matura Intake                      | 49                 | 49                     | 45                   | 49     | 49     | 49     |                    |
| Tompre Waterworks                  | 1,426              | 4,546                  | -                    | -      | -      | -      | Abandon by 1985    |
| Toco Intake                        | -                  | 4,546                  | 1,200                | 3,000  | 4,000  | 4,546  | New Source by 1985 |
| Carlson Field Wells                | 12,729             | 18,180                 | 13,000               | 15,000 | 18,180 | 18,180 |                    |
| Freeport Wells                     | 7,205              | 11,360                 | 7,800                | 9,000  | 11,360 | 11,360 |                    |
| Mayaro Wells                       | 1,050              | 1,477                  | 1,100                | 1,300  | 1,477  | 1,477  |                    |
| Asoco Wells                        | 1,898              | 2,000                  | 1,800                | 1,900  | 2,000  | 2,000  |                    |
| Tanaco to Guayaguayare             | 103                | 180                    | 100                  | 150    | 150    | 180    |                    |
| Guaracara Springs                  | 1,118              | 1,136                  | 1,125                | 1,136  | 1,136  | 1,136  |                    |
| Morichal Springs                   | 446                | 718                    | 500                  | 600    | 718    | 718    |                    |
| Clark Road Wells                   | 374                | 623                    | 400                  | 500    | 623    | 623    |                    |
| Penal Waterworks                   | 2,666              | 3,500                  | 2,700                | 3,000  | 3,500  | 3,500  |                    |
| Pyabed Waterworks                  | 1,105              | 1,500                  | 1,200                | 1,400  | 1,500  | 1,500  |                    |
| Siparia (Coora) Waterworks         | 2,827              | 3,033                  | 2,700                | 3,033  | 3,033  | 3,033  |                    |
| Carpal/Erin Waterworks             | 1,122              | 1,400                  | 1,200                | 1,400  | 1,400  | 1,400  |                    |
| Cop-de-Ville Waterworks            | 1,006              | 1,006                  | 1,000                | 1,006  | 1,006  | 1,006  |                    |
| Point Fortin Waterworks            | 746                | 980                    | 850                  | 980    | 980    | 980    |                    |
| Granville Waterworks               | 2,713              | 2,800                  | 2,700                | 2,800  | 2,800  | 2,800  |                    |
| Atagual Springs                    | 426                | 630                    | 400                  | 500    | 630    | 630    |                    |
| Trintec to Techier                 | 345                | 418                    | 300                  | -      | -      | -      | Abandon by 1987    |
| Trintec to Point Fortin            | 162                | 250                    | 150                  | -      | -      | -      | Abandon by 1987    |

表 4-12 トリニダード島水源と生産能力(3) (1984~2000年)

EXISTING AND PROJECTED SUPPLY CAPABILITY OF WASH WATER SOURCES (1984 - 2000)

DAILY AVERAGE PRODUCTION (m<sup>3</sup>/d)

| SUPPLY SOURCE                      | PRODUCTION<br>1984 | PRODUCTION<br>CAPACITY | PROJECTED PRODUCTION |         |         |         | REMARKS                                               |
|------------------------------------|--------------------|------------------------|----------------------|---------|---------|---------|-------------------------------------------------------|
|                                    |                    |                        | 1985                 | 1990    | 1995    | 2000    |                                                       |
| Blanchisseuse Waterworks           | 143                | 143                    | 140                  | 143     | 143     | 143     | Abandon by 1985<br>Abandon by 1985<br>Abandon by 1985 |
| Blanchisseuse Intake               | 61                 | 61                     | 50                   | 61      | 61      | 61      |                                                       |
| Las Cuevas Intake                  | 116                | 120                    | 100                  | 120     | 120     | 120     |                                                       |
| Tyrice Intake                      | 217                | 900                    | 300                  | 500     | 700     | 900     |                                                       |
| Morne la Croix Intake              | 27                 | 45                     | 40                   | 45      | 45      | 45      |                                                       |
| Brasso Seco-Paria Intake           | 27                 | 45                     | 40                   | 45      | 45      | 45      |                                                       |
| Lluengo Intake                     | 105                | 200                    | -                    | -       | -       | -       |                                                       |
| Water Fall Road Intake             | 91                 | 160                    | -                    | -       | -       | -       |                                                       |
| Pt. Coco Waterworks                | 675                | 2,270                  | -                    | -       | -       | -       |                                                       |
| El Socorro Waterworks              | 17,528             | 27,272                 | 19,000               | 23,000  | 25,000  | 27,272  |                                                       |
| Valasayn Waterworks                | 15,627             | 27,280                 | 17,000               | 22,000  | 25,000  | 27,280  | New Source by 1995                                    |
| Acono Waterworks                   | 1,814              | 2,100                  | 1,900                | 2,100   | 2,100   | 2,100   |                                                       |
| Lluengo/Haranjo Intake             | 2,908              | 3,180                  | 3,000                | 3,180   | 3,180   | 3,180   |                                                       |
| Hollis Reservoir                   | 31,826             | 31,826                 | 31,700               | 31,826  | 31,826  | 31,826  |                                                       |
| Tacarigua Wells                    | 3,244              | 14,550                 | 3,500                | 6,000   | 10,000  | 14,550  |                                                       |
| Aripo Waterworks                   | 11,627             | 15,300                 | 12,500               | 14,000  | 15,900  | 15,900  |                                                       |
| Guanapo Waterworks                 | 4,019              | 11,360                 | 5,500                | 9,000   | 11,360  | 11,360  |                                                       |
| Aripo Intake                       | 15                 | 45                     | 25                   | 45      | 45      | 45      |                                                       |
| North Dropoucha                    | 40,567             | 90,920                 | 50,000               | 75,000  | 90,920  | 90,920  |                                                       |
| Caroni-Arena Water Treatment Plant | 234,683            | 272,760                | 242,000              | 260,000 | 272,760 | 272,760 |                                                       |
| Caura Waterworks                   | 9,252              | 11,360                 | 9,500                | 10,200  | 11,360  | 11,360  | Production capability does not include Moruga.        |
| Las Lomas Waterworks               | 5,790              | 11,360                 | 6,200                | 9,000   | 11,360  | 11,360  |                                                       |
| Navet Waterworks                   | 74,072             | 77,280                 | 74,000               | 77,280  | 77,280  | 77,280  |                                                       |
| Chatham Waterworks                 | 1,273              | 11,365                 | 3,000                | 5,000   | 8,000   | 11,365  |                                                       |
| Moruga Waterworks                  | -                  | 113,650                | -                    | -       | 69,190  | 113,650 | Production capability does not include Moruga.        |
| TOTAL (m <sup>3</sup> /d) (MED)    | 586,924            | 787,483                | 613,821              | 695,205 | 825,608 | 887,724 |                                                       |
|                                    | 129                | 173                    | 135                  | 153     | 181     | 195     |                                                       |

表4-13 トリニダード島水源別取水割合 (1978~1984年)

PERCENTAGE OF SURFACE AND GROUND WATER SUPPLY SOURCES IN TRINIDAD

| SOURCE  | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985* |
|---------|------|------|------|------|------|------|------|-------|
| SURFACE | 39.1 | 41.9 | 52.3 | 63.8 | 71.3 | 72.7 | 72.0 | 83    |
| GROUND  | 60.9 | 58.1 | 47.7 | 36.2 | 28.7 | 27.3 | 28.0 | 17    |

出所: WASA

The Water System Balance in Trinidad

※は Surface Water Report (1984/85)

表4-14 トバゴ島の水源別浄水量

| 水 源                   | 年間浄水量 (m <sup>3</sup> ) | 日平均浄水量 (m <sup>3</sup> ) |
|-----------------------|-------------------------|--------------------------|
| Hillsborough Dam      | 2, 143, 650             | 5, 873                   |
| Charlotteville        | 147, 150                | 403                      |
| Richmond              | 554, 200                | 1, 519                   |
| Courland Waterworks   | 2, 246, 600             | 6, 155                   |
| Castara               | * 35, 780               | 98                       |
| Bloody Bay            | * 1, 800                | 5                        |
| L'Anse Fourmi         | * 8, 370                | 23                       |
| Parlatuvier           | * 2, 220                | 6                        |
| Soeyside              | * 127, 750              | 350                      |
| Craig Hall            | 379, 610                | 1, 040                   |
| Greenhill Intake      | 494, 640                | 1, 355                   |
| Kings Bay Water Works | 525, 120                | 1, 439                   |
| Gov't Farm Wall #3    | 59, 560                 | 163                      |
| TOTAL                 | 6, 726, 450             | 18, 429                  |

注) \*印は推定

表4-15 トリニダード島水需給 (1985~2000年)

PROJECTED WATER SYSTEM BALANCE IN TRINIDAD

35% LOSSES

| YEAR | DEMAND<br>(m <sup>3</sup> /d) | SUPPLY<br>(m <sup>3</sup> /d) | BALANCE<br>(m <sup>3</sup> /d) |
|------|-------------------------------|-------------------------------|--------------------------------|
| 1985 | 611,028                       | 613,821                       | + 2,793                        |
| 1990 | 759,919                       | 695,205                       | - 64,714                       |
| 1995 | 962,552                       | 825,608                       | - 136,944                      |
| 2000 | 1,169,623                     | 887,724                       | - 281,899                      |

出所: WASA

The Water System Balance in Trinidad

表4-16 漏水率 (1985~2000年)

PERCENTAGES OF SYSTEM LOSSES

| YEAR | NET DEMAND<br>(m <sup>3</sup> /d) | SYSTEM LOSSES<br>(m <sup>3</sup> /d) | GROSS DEMAND<br>(m <sup>3</sup> /d) | PROJECTED<br>SUPPLY<br>(m <sup>3</sup> /d) | LOSSES AS<br>PERCENTAGE OF<br>NET DEMAND<br>(%) | LOSSES AS<br>PERCENTAGE OF<br>GROSS DEMAND<br>(%) | LOSSES AS<br>PERCENTAGE OF<br>PROJECTED<br>SUPPLY<br>(%) |
|------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------------------|-------------------------------------------------|---------------------------------------------------|----------------------------------------------------------|
| 1985 | 452,613                           | 158,415                              | 611,028                             | 613,821                                    | 35                                              | 25.9                                              | 25.8                                                     |
| 1985 | 452,613                           | 226,288                              | 678,901                             | 613,821                                    | 50                                              | 33.3                                              | 36.9                                                     |
| 1990 | 562,903                           | 197,016                              | 759,919                             | 695,205                                    | 35                                              | 25.9                                              | 28.3                                                     |
| 1990 | 562,903                           | 281,265                              | 844,168                             | 695,205                                    | 50                                              | 33.3                                              | 40.4                                                     |
| 1995 | 713,001                           | 249,551                              | 962,552                             | 825,608                                    | 35                                              | 25.9                                              | 30.2                                                     |
| 1995 | 713,001                           | 356,104                              | 1,069,105                           | 825,608                                    | 50                                              | 33.3                                              | 43.1                                                     |
| 2000 | 866,387                           | 303,236                              | 1,169,623                           | 887,724                                    | 35                                              | 25.9                                              | 34.2                                                     |
| 2000 | 866,387                           | 432,516                              | 1,298,903                           | 887,724                                    | 50                                              | 33.3                                              | 48.7                                                     |

出所: WASA

The Water System Balance in Trinidad 1983年

表4-17 トリニダッド・トバゴ主要水源の処理施設状況

| <u>SOURCE</u>                       | <u>DAILY AVERAGE<br/>PRODUCTION<br/>(m<sup>3</sup>/d)</u> | <u>TREATMENT</u>   |
|-------------------------------------|-----------------------------------------------------------|--------------------|
| <b>IMPOUNDING RESERVOIRS</b>        |                                                           |                    |
| Caroni/Arena                        | 248,000                                                   | Sed, Fil, Chl      |
| Navet                               | 77,280                                                    | Sed, Fil, Chl      |
| Hollis                              | 22,730                                                    | Fil, Chl           |
| * Hillsborough                      | 5,860                                                     | Sed, Fil, Chl      |
| <b>SURFACE &amp; RIVER SUPPLIES</b> |                                                           |                    |
| Toco Waterworks                     | 2,250                                                     | Sed, Fil, Chl      |
| Valencia Intake                     | 3,530                                                     | Chl                |
| Aripo Waterworks                    | 12,830                                                    | Sed, Fil, Chl      |
| * Richmond Waterworks               | 2,130                                                     | Sed, Fil, Chl      |
| * Courland Waterworks               | 5,890                                                     | Sed, Fil, Chl      |
| * Craig Hall                        | 1,170                                                     | Chl                |
| Acono                               | 2,270                                                     | Sed, Fil, Chl      |
| Lluengo/Naranjo Waterworks          | 3,585                                                     | Sed, Fil, Chl      |
| * King's Bay                        | 1,650                                                     | Chl                |
| North Oropouche                     | 72,640                                                    | Sed, Fil, Chl      |
| Caura                               | 10,490                                                    | Sed, Fil, Chl      |
| Guanapo                             | 11,360                                                    | Sed, Fil, Chl      |
| <b>WELLS SUPPLIES</b>               |                                                           |                    |
| Paramin.                            | 600                                                       | Chl                |
| El Socorro                          | 22,170                                                    | Aer, Chl           |
| Farrell                             | 6,000                                                     | Chl                |
| St. Clair                           | 1,450                                                     | Chl                |
| Queen's Park Savannah               | 9,870                                                     | Chl                |
| King George V                       | 7,000                                                     | Chl                |
| Moka                                | 2,100                                                     | Chl                |
| Tucker Valley                       | 13,450                                                    | Chl                |
| Four Roads, Diego Martin            | 28,810                                                    | Chl                |
| River Estate, Diego Martin          | 6,210                                                     | Chl                |
| Valsayn                             | 18,300                                                    | Aer, Chl           |
| La Pastora                          | 1,140                                                     | Chl                |
| Arima                               | 450                                                       | Chl                |
| Tacarigua                           | 5,800                                                     | Chl                |
| Arouca                              | 1,400                                                     | Chl                |
| Carlsen Field                       | 9,090                                                     | Aer, Sed, Fil, Chl |
| Freeport                            | 4,580                                                     | Aer, Sed, Fil, Chl |
| Guaracara/Morichal                  | 1,820                                                     | Chl                |
| Las Lomas                           | 10,720                                                    | Aer, Sed, Fil, Chl |
| Point Fortin                        | 510                                                       | Aer, Fil, Chl      |
| Penal                               | 3,230                                                     | Aer, Sed, Fil, Chl |
| Mayaro                              | 3,000                                                     | Aer, Chl           |
| Granville                           | 2,800                                                     | Aer, Sed, Fil, Chl |
| Cap-De-Ville                        | 750                                                       | Aer, Sed, Chl      |
| Fyzabad                             | 1,600                                                     | PP, Fil, Chl       |
| Clarke Road                         | 450                                                       | -                  |
| Coora                               | 3,000                                                     | Aer, Sed, Fil, Chl |
| Dorrington Gardens                  | 2,600                                                     | Chl                |
| Caxapal                             | 1,820                                                     | Fil, Chl           |
| Amoco                               | 2,300                                                     | Fil, Chl           |
| Chatham                             | 5,000                                                     | Fil, Chl           |

※印はトバゴ島

Aer - Aeration; Sed - Sedimentation; Fil - Filtration  
Chl - Chlorination; PP - Potassium Permanganate

出所: WASA

表4-18 CARONI-ARENA給水システム工事契約一覧

## CARONI-ARENA WATER SUPPLY PROJECT

## LIST OF CONTRACTS AND COSTS

| Contract Name                                                          | Contractor                                                                                                         | Contract Sum<br>(Millions)<br>Initial Sum | Final<br>Const.<br>Costs* |
|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------|
| Contract No. 1<br>Pumped Storage<br>Complex                            | Fujiko Company Limited                                                                                             | \$ 43.9                                   | 49.3                      |
| Contract No. 2<br>Caroni Water Treat-<br>ment Plant                    | Rex Wa Lee - A Joint Ven-<br>ture of Rexach Corporation<br>and Sam P. Wallace (Puerto<br>Rico)/Fred Chin Lee (T&T) | \$104.4                                   | 100.0                     |
| Contract No. 4A<br>Supply and Installa-<br>tion of Pipes and<br>Valves | Trinidad Contractors/Pipe-<br>con BV a Joint Venture of<br>Trinidad Contractors Ltd.<br>(T&T) Pipecon BV (Holland) | \$106.9                                   | 115.0                     |
| Contract No. 5<br>Booster Pump Stns.                                   | Pizzagalli Construction<br>Company Limited U.S.A.                                                                  | \$ 12.0                                   | 12.5                      |
| Contract No. 6<br>Service Reservoirs<br>(Concrete)                     | Trinidad Contractors<br>Limited (T&T)                                                                              | \$ 13.8                                   | 13.0                      |
| Contract No. 6A<br>Service Reservoirs<br>(Steel)                       | Damus Limited (T&T)                                                                                                | <u>\$ 5.0</u>                             | <u>5.0</u>                |
| Constr. Cost Sub-<br>Total                                             |                                                                                                                    | <u>\$286.0</u>                            | 294.8                     |
| + Indirect Costs                                                       |                                                                                                                    |                                           | 60.0                      |
| TOTAL                                                                  |                                                                                                                    |                                           | <u>354.8</u>              |

\* Final Construction Costs as of June 1983 do not allow for the possibility that some Contractors may win additional costs through claims

+ Indirect costs include surveying, testing, engineering, inspections, special investigations, training, instruments, tools and spare parts.

出所: WASA

表4-19 カロニ/アレナ給水システム施設状況(1)

CAPACITY DATA OF PROJECT ELEMENTS

| <u>PROJECT ELEMENT</u>                      |                                 | <u>VALUE</u>                                       |
|---------------------------------------------|---------------------------------|----------------------------------------------------|
| <u>PUMPED STORAGE COMPLEX</u>               |                                 |                                                    |
| Arena Reservoir                             | Capacity at 119 ft. amsl.       | (43,187,000m <sup>3</sup> )<br>9,500 million gals. |
|                                             | Area at 119 ft. amsl.           | 1,700 acres (647ha)                                |
| Arena Dam                                   | Top Elevation                   | 134 ft. amsl.                                      |
|                                             | Tailwater Elevation             | 53 ft. amsl.                                       |
|                                             | Water Level, Full               | 119 ft. amsl.                                      |
| Tumpuna Weir                                | Crest Elevation                 | 53 ft. amsl.                                       |
| Tumpuna Pump Station                        | No. of Pumps                    | 6                                                  |
|                                             | Capacity of each pump           | 14 mgd. (64,000m <sup>3</sup> /日)                  |
| Staff House                                 | No. of Bedrooms                 | 3                                                  |
|                                             | Floor Area                      | 2500 sq. ft.                                       |
| Recreation Facilities                       | Parking Spaces                  | 47 cars                                            |
|                                             | Covered Shelters                | 5                                                  |
|                                             | Picnic Tables                   | 50                                                 |
| <u>CARONI WATER TREATMENT PLANT</u>         |                                 |                                                    |
| Treatment Plant                             | Nominal Capacity                | 60 mgd (273,000m <sup>3</sup> /日)                  |
|                                             | Chemicals                       | Alum                                               |
|                                             |                                 | Sodium                                             |
|                                             |                                 | Hypochlorite                                       |
|                                             |                                 | Lime                                               |
|                                             |                                 | Polymers                                           |
| Intake Works                                | Number and Capacity<br>of Pumps | 6 at 12 mgd (55,000m <sup>3</sup> /日)              |
|                                             |                                 | 2 at 6 mgd (27,000m <sup>3</sup> /日)               |
| Flocculation and<br>Sedimentation<br>Basins | Number                          | 5                                                  |
|                                             | Dimension                       | 40ft x 290 ft each<br>(12m x 88m)                  |
| Activated Carbon<br>Filters                 | Number                          | 6                                                  |
|                                             | Depth                           | 5' each                                            |
| High Head Pumps                             | Number                          | 9                                                  |
| Sludge Lagoons                              | Number                          | 2                                                  |
|                                             | Area of each                    | 10 acres (40ha)                                    |
| Staff Housing                               | No. of units                    | 10                                                 |



表4-19 カロニ/アレナ給水システム施設状況(2)

PIPELINES

|                               |                              |                                                           |
|-------------------------------|------------------------------|-----------------------------------------------------------|
| 24" diameter pipe<br>(610mm)  | Length<br>Capacity (approx*) | 25,000 ft. (7,620m)<br>8.5 mgd. (39,000m <sup>3</sup> )   |
| 30" diameter pipe<br>(762mm)  | Length<br>Capacity           | 25,000 ft.<br>13.2 mgd. (60,000m <sup>3</sup> )           |
| 36" diameter pipe<br>(914mm)  | Length<br>Capacity           | 33,000 ft. (10,058m)<br>19.1 mgd. (87,000m <sup>3</sup> ) |
| 42" diameter pipe<br>(1067mm) | Length<br>Capacity           | 39,000 ft. (11,887m)<br>26 mgd. (118,000m <sup>3</sup> )  |
| 48" diameter pipe<br>(1219mm) | Length<br>Capacity           | 50,000 ft. (15,240m)<br>34 mgd. (155,000m <sup>3</sup> )  |
| 54" diameter pipe<br>(1372mm) | Length<br>Capacity           | 92,000 ft. (24,041m)<br>43 mgd. (195,000m <sup>3</sup> )  |

BOOSTER PUMP STATIONS

|                      |                                                                                  |                                                                                |
|----------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Valsayn BPS          | Station Elev. amsl<br>Rated head<br>No. & Capacity of Pumps<br>Top Service Level | 58 ft.<br>180 ft. (55m)<br>3 at 4 mgd. (18,000m <sup>3</sup> /日)<br>300 ft.    |
| El Socorro BPS       | Station Elev. amsl<br>Rated Head<br>No. & Capacity of Pumps<br>Top Service Level | 20 ft.<br>210 ft. (64m)<br>3 at 10 mgd. (45,000m <sup>3</sup> /日)<br>310 ft.   |
| San Fernando BPS     | Station Elev. amsl<br>Rated Head<br>No. & Capacity of Pumps<br>Top Service Level | 100 ft.<br>150 ft. (46m)<br>3 at 7.5 mgd. (34,000m <sup>3</sup> /日)<br>263 ft. |
| El Socorro Clearwell | Station Elev. amsl<br>Rated Head<br>No. & Capacity of Pumps<br>Top Service Level | 20 ft.<br>250 ft. (76m)<br>4 at 3.3 mgd. (15,000m <sup>3</sup> /日)<br>229 ft.  |

\*assumes 5 FPS average velocity

表4-19 カロニ/アレナ給水システム施設状況(3)

TABLE 1-3 (Cont'd)

SERVICE RESERVOIRS

|              |                                                       |                                                                     |
|--------------|-------------------------------------------------------|---------------------------------------------------------------------|
| Picton #3    | Material<br>Volume<br>Elevations<br>- Top<br>- Bottom | Concrete<br>10 m.g. (45,000m <sup>3</sup> /日)<br>313 ft.<br>278 ft. |
| Malick       | Material<br>Volume<br>Elevations<br>- Top<br>- Bottom | Concrete<br>5 m.g. (23,000m <sup>3</sup> /日)<br>178 ft.<br>153 ft.  |
| Mt. Hope     | Material<br>Volume<br>Elevations<br>- Top<br>- Bottom | Concrete<br>5 m.g. (23,000m <sup>3</sup> /日)<br>300 ft.<br>263 ft.  |
| California   | Material<br>Volume<br>Elevations<br>- Top<br>- Bottom | Steel<br>5 m.g. (23,000m <sup>3</sup> /日)<br>196 ft.<br>162 ft.     |
| San Fernando | Material<br>Volume<br>Elevations<br>- Top<br>- Bottom | Steel<br>5 m.g. (23,000m <sup>3</sup> /日)<br>181 ft.<br>147 ft.     |

表4-20 トリニダード・トバゴ便所施設普及状況

TABLE 6.6. PERCENTAGE DISTRIBUTION OF DWELLING UNITS BY TYPE OF TOILET FACILITIES AND ADMINISTRATIVE AREA, 1970 AND 1980

| Administrative area              | Type of toilet facilities |       |                      |                          |       |            |
|----------------------------------|---------------------------|-------|----------------------|--------------------------|-------|------------|
|                                  | Total                     | Pit   | W.C. linked to sewer | W.C. not linked to sewer | Other | Not stated |
| 1970                             |                           |       |                      |                          |       |            |
|                                  | (1)                       | (2)   | (3)                  | (4)                      | (5)   | (6)        |
| Trinidad and Tobago ...          | 100.00                    | 70.42 | 12.20                | 15.45                    | 0.19  | 1.74       |
| Port of Spain ...                | 100.00                    | 32.63 | 51.60                | 13.91                    | 0.42  | 1.44       |
| San Fernando ...                 | 100.00                    | 24.33 | 46.26                | 27.88                    | 0.25  | 1.28       |
| Arima (Borough) ...              | 100.00                    | 47.91 | 40.22                | 9.87                     | 0.00  | 2.00       |
| St. George ...                   | 100.00                    | 64.91 | 13.55                | 19.83                    | 0.20  | 1.51       |
| Caroni ...                       | 100.00                    | 89.16 | 1.03                 | 8.25                     | 0.11  | 1.45       |
| Nariva/Mayaro ...                | 100.00                    | 87.48 | 1.57                 | 7.82                     | 0.18  | 2.95       |
| St. Andrew/St. David ...         | 100.00                    | 89.97 | 0.67                 | 7.99                     | 0.12  | 1.26       |
| Victoria ...                     | 100.00                    | 81.16 | 2.03                 | 14.40                    | 0.13  | 2.28       |
| St. Patrick ...                  | 100.00                    | 81.32 | 2.44                 | 14.18                    | 0.16  | 1.90       |
| Tobago ...                       | 100.00                    | 80.14 | 3.69                 | 13.48                    | 0.28  | 2.41       |
| 1980                             |                           |       |                      |                          |       |            |
| Trinidad and Tobago ...          | 100.00                    | 58.05 | 19.95                | 21.14                    | 0.07  | 0.80       |
| Port of Spain ...                | 100.00                    | 27.58 | 65.38                | 5.58                     | 0.05  | 1.41       |
| San Fernando ...                 | 100.00                    | 14.30 | 76.66                | 8.43                     | 0.01  | 0.60       |
| Arima (Borough) <sup>1</sup> ... | 100.00                    | 41.73 | 44.14                | 13.20                    | 0.16  | 0.77       |
| St. George ...                   | 100.00                    | 49.61 | 28.23                | 21.30                    | 0.04  | 0.82       |
| Caroni ...                       | 100.00                    | 74.50 | 2.32                 | 22.60                    | 0.02  | 0.56       |
| Nariva/Mayaro ...                | 100.00                    | 81.24 | 4.24                 | 13.09                    | 0.28  | 1.15       |
| St. Andrew/St. David ...         | 100.00                    | 78.76 | 2.97                 | 17.58                    | 0.10  | 0.59       |
| Victoria ...                     | 100.00                    | 66.89 | 3.47                 | 28.89                    | 0.06  | 0.69       |
| St. Patrick ...                  | 100.00                    | 71.47 | 5.23                 | 22.49                    | 0.10  | 0.72       |
| Tobago ...                       | 100.00                    | 65.31 | 3.37                 | 29.89                    | 0.18  | 1.25       |

<sup>1</sup>The expanded Borough of Arima (1980) contains nine (9) enumeration districts (in whole or in part) previously contained in the Ward of Arima.

Source: Population and Housing Census.  
C.S.O

表4-21 カロニ浄水場薬品使用状況

Use of Chemicals at Caroni WTP

River Intake Figures

| Year | Monthly Total m <sup>3</sup> | Monthly Average m <sup>3</sup> | Alum Kg/month |
|------|------------------------------|--------------------------------|---------------|
| 1985 | 7,344,074                    | 244,802                        | 354080        |
| 1986 | 7,914,310                    | 263,810                        | 384,367       |
| 1987 | 8,088,737                    | 269,625                        | 397,979       |

Present (1988) costs - approx usage and costs:-

Aluminium Sulphate - 1200 TT \$/tonne  
 Hydrated lime - 860 TT \$/tonne  
 Liquid Chlorine - 4780 TT \$/2000 lbs

- a) Alum costs =  $4775 \text{ tonnes/annum} \times 1200 \text{ TT \$}$   
                   = 5,730,898 TT \$/annum
- b) Lime costs =  $269,625 \times \frac{20}{1000} \times \frac{1}{1000} \times 860 \times 365$   
                   = 1,692,706 TT \$/annum
- c) Liquid chlorine = 3000 lbs/day  
                       = 7170 x 365  
                       = 2,617,050 TT \$/annum
- d) Activated carbon - Used as required to top up

合計 a)~c) 10,040,655 TT \$/year

出所: WASA

CARONI River Water Pollution Study

表4-22 カロニ浄水場水質分析データ(1)

SOURCE: CARONI FINAL

YEAR: 1988

| CHARACTERISTICS                              | JANUARY - MAY |             |     | JUNE - DECEMBER |             |     |
|----------------------------------------------|---------------|-------------|-----|-----------------|-------------|-----|
|                                              | MEAN          | RANGE       | NO. | MEAN            | RANGE       | NO. |
| Colour (Hazen Units)                         | 9             | 0 - 30      | 20  | 6               | 0 - 15      | 16  |
| Turbidity (Formazin Units)                   | 3.3           | 0.05 - 17   | 20  | 2.2             | 0.5 - 3.0   | 16  |
| pH                                           | 7.3           | 6.7 - 9.0   | 20  | 6.9             | 6.0 - 8.0   | 16  |
| Specific Conductivity (umhos)                | 183           | 160 - 260   | 20  | 185             | 125 - 295   | 16  |
| pHs                                          | 8.7           | 8.4 - 9.0   | 8   | 8.8             | 8.5 - 9.1   | 5   |
| <u>The following are expressed in mg/L</u>   |               |             |     |                 |             |     |
| Alkalinity, Total ( $\text{CaCO}_3$ )        | 61            | 38 - 86     | 20  | 46              | 22 - 86     | 16  |
| Alkalinity, Bicarbonate ( $\text{HCO}_3^-$ ) | 73            | 47 - 105    | 20  | 56              | 27 - 105    | 16  |
| Alkalinity, Carbonate ( $\text{CO}_3^{2-}$ ) | 0.8           | 0 - 4.8     | 16  |                 | 0           |     |
| Free Carbon Dioxide                          |               | -           | -   |                 | -           |     |
| Hardness, Total ( $\text{CaCO}_3$ )          | 83            | 59 - 113    | 20  | 82              | 51 - 137    | 16  |
| Calcium ( $\text{Ca}^{2+}$ )                 | 25            | 16 - 35     | 20  | 25              | 14 - 47     | 16  |
| Magnesium ( $\text{Mg}^{2+}$ )               | 5.5           | 2.2 - 7.4   | 19  | 4.7             | 2.0 - 8.8   | 16  |
| Chloride ( $\text{Cl}^-$ )                   | 22            | 18 - 28     | 19  | 21              | 13 - 32     | 16  |
| Residual Chlorine ( $\text{Cl}_2$ )          | 2.6           | 0.2 - 3.5   | 20  | 3.9             | 0.2 - 5.0   | 16  |
| $\text{O}_2$ from $\text{KMnO}_4$ (44°C)     | 0.5           | 0.3 - 1.2   | 19  | 0.26            | 0 - 0.85    | 16  |
| Iron, Total ( $\text{Fe}^{3+}$ )             | 0.09          | 0.03 - 0.19 | 19  | 0.09            | 0 - 0.21    | 14  |
| Iron, Soluble ( $\text{Fe}^{2+}$ )           |               | -           | -   |                 | -           |     |
| Sulphate ( $\text{SO}_4^{2-}$ )              | 24            | 17 - 47     | 20  | 33              | 13 - 49     | 16  |
| Silicate ( $\text{SiO}_2$ )                  | 9.0           | 7.8 - 11.0  | 19  | 7.9             | 5.4 - 11.3  | 13  |
| Phosphate (P)                                | 0.02          | 0.01 - 0.03 | 19  | 0.02            | 0.01 - 0.04 | 10  |
| Fluoride ( $\text{F}^-$ )                    |               | -           | -   |                 | -           |     |
| Ammonia, Free & Saline (N)                   |               | -           | -   |                 | -           |     |
| Ammonia, Albuminoid (N)                      |               | -           | -   |                 | -           |     |
| Total Nitrogen (N)                           |               | -           | -   |                 | -           |     |
| Nitrate (N)                                  |               | -           | -   |                 | -           |     |
| Sodium ( $\text{Na}^+$ )                     | 12            | 11 - 14     | 10  | 9.0             | 4.8 - 15.3  | 8   |
| Potassium ( $\text{K}^+$ )                   | 2.4           | 1.8 - 3.1   | 10  | 2.3             | 1.4 - 3.6   | 9   |
| Aluminium ( $\text{Al}^{3+}$ )               | 0.05          | 0.01 - 0.15 | 12  | 0.06            | 0.02 - 0.19 | 7   |
| Total Dissolved Solids (180°C)               | 130           | 105 - 166   | 16  | 134             | 94 - 207    | 10  |
| Total Suspended Solids (105°C)               |               | -           | -   |                 | -           |     |
| Total Solids (180°C)                         |               | -           | -   |                 | -           |     |
| Dissolved Oxygen (DO)                        |               | -           | -   |                 | -           |     |
| Total Organic Carbon (TOC)                   |               | -           | -   |                 | -           |     |
| Heavy Metals                                 |               | -           | -   |                 | -           |     |

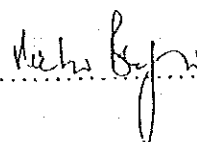
*Heidi G. ...* 89:06:02

表4-22 カロニ浄水場水質分析データ(2)

SOURCE: CARONI RAW

YEAR: 1988

| CHARACTERISTICS                                          | JANUARY - MAY |             |     | JUNE - DECEMBER  |                       |     |
|----------------------------------------------------------|---------------|-------------|-----|------------------|-----------------------|-----|
|                                                          | MEAN          | RANGE       | NO. | MEAN             | RANGE                 | NO. |
| Colour (Hazen Units)                                     | 90            | 50 - 200    | 19  | 250 <sup>+</sup> | 70 - 250 <sup>+</sup> | 14  |
| Turbidity (Formazin Units)                               | 31            | 16 - 70     | 19  | 113              | 20 - 250              | 14  |
| pH                                                       | 7.3           | 7.1 - 7.4   | 19  | 7.2              | 6.9 - 7.5             | 13  |
| Specific Conductivity (umhos)                            | 170           | 135 - 220   | 19  | 151              | 100 - 240             | 14  |
| pHs                                                      |               |             | 0   | 8.7              | 8.4 - 8.8             | 4   |
| <u>The following are expressed in mg/L</u>               |               |             |     |                  |                       |     |
| Alkalinity, Total (CaCO <sub>3</sub> )                   | 64            | 55 - 86     | 19  | 70               | 40 - 94               | 14  |
| Alkalinity, Bicarbonate (HCO <sub>3</sub> <sup>-</sup> ) | 81            | 67 - 105    | 19  | 86               | 49 - 114              | 14  |
| Alkalinity, Carbonate (CO <sub>3</sub> <sup>2-</sup> )   |               | 0           | 19  |                  | 0                     |     |
| Free Carbon Dioxide                                      |               | -           | -   |                  | -                     | -   |
| Hardness, Total (CaCO <sub>3</sub> )                     | 71            | 57 - 90     | 19  | 67               | 38 - 104              | 14  |
| Calcium (Ca <sup>2+</sup> )                              | 19            | 14 - 26     | 19  | 21               | 12 - 35               | 14  |
| Magnesium (Mg <sup>2+</sup> )                            | 5.5           | 3.5 - 8.3   | 19  | 3.9              | 0.5 - 9.3             | 14  |
| Chloride (Cl <sup>-</sup> )                              | 17            | 15 - 23     | 18  | 15               | 9 - 23                | 14  |
| Residual Chlorine (Cl <sub>2</sub> )                     |               | -           | -   |                  | -                     | -   |
| O <sub>2</sub> from KMnO <sub>4</sub> (44°C)             | 2.7           | 1.1 - 3.3   | 19  | 6.9              | 2.9 - 11.8            | 14  |
| Iron, Total (Fe <sup>3+</sup> )                          | 1.1           | 0.6 - 1.9   | 18  | 2.4              | 1.1 - 3.5             | 11  |
| Iron, Soluble (Fe <sup>2+</sup> )                        |               | -           | -   |                  | -                     | -   |
| Sulphate (SO <sub>4</sub> <sup>2-</sup> )                | 9.5           | 5.8 - 11.5  | 18  | 10.3             | 0.2 - 30              | 14  |
| Silicate (SiO <sub>2</sub> )                             | 10.5          | 9.5 - 11.8  | 4   | 8.0              | 6.4 - 9.3             | 4   |
| Phosphate (P)                                            | 0.07          | 0.02 - 0.17 | 17  | 0.06             | 0.03 - 0.08           | 9   |
| Fluoride (F <sup>-</sup> )                               |               | -           | -   |                  | -                     | -   |
| Ammonia, Free & Saline (N)                               |               | -           | -   |                  | -                     | -   |
| Ammonia, Albuminoid (N)                                  |               | -           | -   |                  | -                     | -   |
| Total Nitrogen (N)                                       |               | -           | -   |                  | -                     | -   |
| Nitrate (N)                                              |               | -           | -   |                  | -                     | -   |
| Sodium (Na <sup>+</sup> )                                | 12            | 11 - 15     | 10  | 9                | 5 - 16                | 6   |
| Potassium (K <sup>+</sup> )                              | 2.5           | 1.9 - 3.3   | 9   | 2.4              | 1.5 - 3.8             | 6   |
| Aluminium (Al <sup>3+</sup> )                            |               | -           | -   |                  | -                     | -   |
| Total Dissolved Solids (180°C)                           | 119           | 93 - 165    | 16  | 134              | 99 - 176              | 8   |
| Total Suspended Solids (105°C)                           |               | -           | -   |                  | -                     | -   |
| Total Solids (180°C)                                     |               | -           | -   |                  | -                     | -   |
| Dissolved Oxygen (DO)                                    |               | -           | -   |                  | -                     | -   |
| Total Organic Carbon (TOC)                               |               | -           | -   |                  | -                     | -   |
| Heavy Metals                                             |               | -           | -   |                  | -                     | -   |


 81-06-02



## 第5章 本格調査の内容

### 5-1 調査の基本方針（目的等）

TT国においては、根幹的水道施設の建設が概ね完了していることから、今後のWASAの事業は維持管理の充実を図ることを主眼において施設整備、運転管理のあり方を明確にする必要があると考えられる。

このことから、現状の水道施設の問題点、特に安定度が低いのはどの部分なのかについて的確に把握し、水道施設全体として総合的にバランスのとれた整備を図り、より適正な運用を行う観点から、既存の施設・設備の改修・更新、システムの運転管理方法の改善等について十分検討がなされるべきである。

このためには、TT国全域にわたる基本計画(M/P)の策定が必要である。

最適な水運用管理を行うための主体は、あくまでも施設設備であるが、これを支援する水道情報監視も必要な要素のひとつであり、既に維持管理時代を迎えたTT国においても中央監視システム(CSS)が水運用支援システムとして位置づけられる。CSSの拡充は水資源の有効活用、配水圧力の適正化等、より効率的、効果的に施設の運転管理を行うために極めて有効な手段である。さらに、監視業務のみならず情報解析により需要予測、施設及び管網運用計画等にも活用可能な機能まで拡張すべきである。

このために、CSSのフィージビリティ・スタディ(F/S)を行う。

### 5-2 対象地域及び範囲

M/PはTT国全域（トバゴ島を含む）

F/Sはトリニダッド島中央部（広域水管理の可能な範囲）

### 5-3 調査項目及び内容

[Phase I: マスタープラン]

#### (1) 資料収集及び解析

- 1) 国家開発政策及び水道計画
- 2) 社会経済指標
- 3) 土地利用
- 4) 地形・地質
- 5) 水文・気象
- 6) 道 路
- 7) 地中埋設物



## 8) その他

### (2) 現地調査

- 1) 現地踏査
- 2) 水文・気象調査
- 3) 地形調査
- 4) 水需要実態調査

#### ① 量水器（メーター）の設置

現在、量水器の設置されていない家庭を中心に、新たに量水器を設置し、需要実態を測定する。設置数は50箇所程度が適当である。対象家庭は、家族数、住宅形成、所得標準などを勘案して選定する。

##### 測定計画

一カ月水量 乾季、雨季各三カ月程度。すでに、量水器が設置されている大口利用者等についても同期間のデータを得る。

日 水 量 乾季、雨季に各1週間程度、1日1回測定して曜日特性等を把握する。

時 間 水 量 乾季、雨季に各2日程度、1時間水量を測定する。夜間については対象者への迷惑を考えて一部省略してもよい。

#### ② アンケート調査

測定対象者の水利用実態を調査する。家族構成、住居条件などの属性、生活習慣、水使用機器などの普及状況、水利用行動、水利用意識などのデータを得る。また、水利用行動、水利用意識の一般的傾向を知るために、測定対象者以外の約1,000件を対象に同じアンケート調査を行う。

業務営業用水については、延べ床面積当たり、従業者当たり原単位を官庁、学校、病院、事務所ビル、大型店舗、ホテル等の大口需要者について調査する。また、工場用水については工場の業種、従業者数、用途等について調査する。

### 5) 漏水量推定調査

#### ① 対象地区の選定と流量計の設置

配水管がブロック化されている住居地区（50～100栓を含む）を2～3箇所選定し、簡易流量計（携帯用）を設置する。

#### ② 測定計算

24時間の流量変化を測定する。同時に簡易水圧計を用いて、2回程度、何箇所かの給水栓で水圧分布を求める。深夜の使用水量を4)の水需要実態調査などから推定して漏水量を求める。

### (3) 既存施設（中央監視システムを含む）の評価調査

#### 1) 水 源

水源水量調査においては、季節ごとの取水可能な水量を調査し、既存水源の能力を確認する。水源水質調査においては、貯水池の水質が富栄養化傾向にあること、また、河川水の汚濁が著しいことから浄水費用の増大を招いていることなどの原因を調査し、改善策について検討する。

#### 2) 浄水施設

施設の老朽度を把握するため、施設概要（竣工年月、構造・形式等）、周辺環境、材料、過去の停電・事故・故障の頻度、度合い、波及範囲、継続時間に関する調査を行う。

また、安定性評価のための施設の相互融通機能、予備機器の有無、バックアップ体制、運転管理状況についての調査をする。

#### 3) 送配水施設

送配水ポンプ場、配水池の配置と系統、水位関係、各系統分担給水区域を調査する。また、管網計算による既存管網の能力検討と配水幹線簡易メーターリングによる系統別配水量、時間変動、水圧分布を調査する。

#### 4) 水需給

既存水源、送配水施設、浄水施設の評価及び水供給実績に基づき水供給能力の評価を行う。

過去の水需要の実績及び前述の水需要実態調査、漏水量推定調査に基づき、水需要の評価を行う。

#### 5) 組織・運営

既存の組織及びその運営状態の評価調査と改善計画の評価調査を行う。

#### 6) 運転・維持管理

既存の運転・維持管理状態の評価調査と改善計画の評価調査を行う。

### (4) 基本指標の設定

#### 1) 目標年次・給水区域の決定

#### 2) 料金体系

#### 3) 設計基準

### (5) 需要予測

#### 1) フレーム 都市計画、人口、経済、産業、地域特性

#### 2) 原単位水量 有収または有効水量ベース

用途別（家庭用、業務営業用・工場用等）工業用水、農業用水

- 3) 計画給水量 水道用水：日平均水量，日最大水量，時間最大水量工業用水  
・農業用水：日平均水量，日最大水量
- (6) 建設資機材，労働力及び地元業者施工能力等調査
- (7) 広域水管理計画の策定
  - 1) 将来水源必要性の検討  
新規貯水池，原水調整池，地下ダム等の建設可能性，妥当性の検討を行う。
  - 2) 新送配水施設の検討，ルート測量等  
現存施設の評価から，施設の統廃合，管路の増強，漏水防止，水圧不足地域解消のための適正な系統別給水設定，維持管理の効率化を図るための配水ブロック化を検討する。
  - 3) 送配水施設の最適配置  
現存送水施設の評価及び新施設の検討をもとに最適配置を検討する。
  - 4) 広域水管理のための情報収集・管理システム  
モニタリング地点，項目，時間間隔，中央システムの機能の検討及び管理のための情報処理と表示内容，指示・コントロールの基本方針の決定を行う。
  - 5) 概算事業費の算出
  - 6) 実施計画の策定
  - 7) 財務経済分析

[Phase II：フィージビリティ・スタディ]

- (1) 基本指標の設定
  - 1) 目標年次の決定
  - 2) 対象区域の決定
  - 3) 給水人口
  - 4) 水需要量
  - 5) 設計基準
- (2) 概略設計
- (3) 広域水管理モニタリング計画
  - 1) モニタリング施設（一部コントロールを含む）と機器の概念設計（仕様書作成を含む）
  - 2) 情報収集と管理情報に関するソフトウェアの概念設計
  - 3) 運転・維持管理計画（トレーニング計画も含む）
- (4) 事業費・運転費・維持管理費概算

- (5) 経済・財務分析（組織・運営計画含む）
- (6) 財政計画
- (7) 社会・経済影響調査
- (8) 住民参加調査
- (9) 実施計画の立案
- (10) 提言（料金体系を含む）

#### 5-4 調査工程

本格調査にS/W（案）工程に沿って、前半の基本計画の策定に8カ月（準備・現地作業に4カ月、国内作業に4カ月）を当て、後半のフィージビリティ・スタディに9カ月（現地作業に3カ月、報告書説明を含め国内作業に6カ月）をかけ、全体17カ月で完了する。

#### 5-5 報告書

調査期間中、以下の種類の報告書を作成する。

- |                      |     |
|----------------------|-----|
| (1) インセプション・レポート     | 15部 |
| (2) プロGRESS・レポート (1) | 15部 |
| (3) インテリム・レポート       | 30部 |
| (4) プロGRESS・レポート (2) | 15部 |
| (5) ドラフト・ファイナル・レポート  | 15部 |
| (6) ファイナル・レポート       | 40部 |

#### 5-6 要員計画（担当分野）

- |               |         |                     |
|---------------|---------|---------------------|
| (1) 総 括       | M/P・F/S |                     |
| (2) 広域水管理計画   | M/P・F/S | 水源と送配水の総合的運用、渇水対策   |
| (3) 水 源       | M/P     | 現存水源の評価調査、地質        |
| (4) 浄 水 施 設   | M/P・F/S | 現存浄水施設の評価、水源水質、浄水水質 |
| (5) 送 配 水 施 設 | M/P・F/S | 現存送配水施設の評価、ネットワーク化  |
| (6) 給 水 管 理   | M/P     | 漏水量推定調査、メーター設置とその効果 |
| (7) 需 要 調 査   | M/P     | 水需要実態調査、需要予測        |
| (8) 水管理システム   | M/P・F/S | モニタリング、コントロールシステム   |
| (9) モニタリング施設  | F/S     | 概念設計（機材調達計画含む）      |
| (ハードウェア設計)    |         |                     |

- |               |         |      |
|---------------|---------|------|
| (10) モニタリング施設 | F/S     | 概念設計 |
| (ソフトウェア設計)    |         |      |
| (11) 社会・都市計画  | M/P     |      |
| (12) 経済評価     | M/P・F/S |      |
| (13) 財務分析     | M/P・F/S |      |

#### 5-7 調査実施のための必要機材

- (1) 量水器（水道メーター） 50個 13mm程度（接続配管材を含む）
- (2) 超音波流量計（携帯用） 1台

#### 5-8 調査実施の際の留意事項

##### (1) 基本計画について

現在、フランスがローンによるトリニダッド島及びトバゴ島の水資源開発を計画しており、需要予測等の点で重複することが予想される。この点について WASA と協議の結果、作業が先行する本調査の結果を、フランス側に利用させることによって重複を避けることで了解した。

このため、需要予測には高精度が要求され、新規水源必要性等の検討に際し、場合によっては、フランス側との調整が必要になることも考えられる。

いずれにしても、水需要、水源開発等に関連する調査検討については、WASA との事前打合わせを十分に行う必要がある。

##### (2) 実施計画について

① 当初は現 CSS システムの改良、拡張を目標としていたが、踏査の結果、これらのシステムは水管理システムの一環としてとらえるべきであり、また、現システムはまったく新しいシステムに更新すべきであるとの考え方になっている。

② 広域水管理計画を策定するに当たっては、水源・浄水施設の原水と送・配水施設の浄水を水量・水質の両面から検討し、有効に運用できる計画とすべきである。

すなわち、水源・浄水施設においては貯水池の水位を測定し、井戸水供給量を考慮しながら乾季の間有効に利用するとか、水質の良好な水源を優先的に利用し、浄水コストを下げるとかという点においてである。

また、送・配水施設においても、これら施設を効果的に配置し、連結し、さらに給水区域のブロック化を計り地盤の高い地区のみが給水されないなどの水圧不足による地域的渇水を生じることのないような計画とすべきである。

③ 導入されるシステムはモニタリングを主とするもので、必要ならば、オフラインで

ポンプ等を遠隔制御できるソフト等を組み込むものとする。全システムの自動制御については、当面考えていない。

④ また、新しいシステムについて、汎用的で、供給国、供給メーカーが限定されないような概念設計を含んだ実施計画を作成する方針である。

⑤ WASAにおいて、コンピュータを利用した管理システムはCSSの他にマッピングシステム、経営管理システムが稼働している。CSSの更新に当たっては、これら他の管理システムとの重複を避け、対象範囲の区分及び関連事項の明確化を図る必要がある。

コンピュータの発達に比して、モニタリング機器は精度面において必ずしも追従できないことが考えられることから、CSSの設計に当たってはモニタリング機器の精度と整合のとれたものとし、安易に複雑な制御系の導入は避けることが望ましい。

### (3) 要員計画について

本調査の内容が多岐にわたり、かつ高普及時代に入ったTT国の水道事情を鑑みるに、「総括」は水道全般についての知識と経験が豊富な技術者が望ましい。

「水管理システム」、「モニタリング施設」の担当者は、水道事業体の水運用センター、配水センター等の計装機器設計に直接携わった経験を有するコンピュータ関連会社等の技術者が望ましい。

対象国が、新CSSシステムの機材供給可能国に近いことから、一部、外国のコンサルタントの利用も考えられる。

### (4) TT国との関係について

① 技術協力の実績がないので、本調査の実施に当たって、常に相手機関に十分事前説明、協議を行う必要がある。

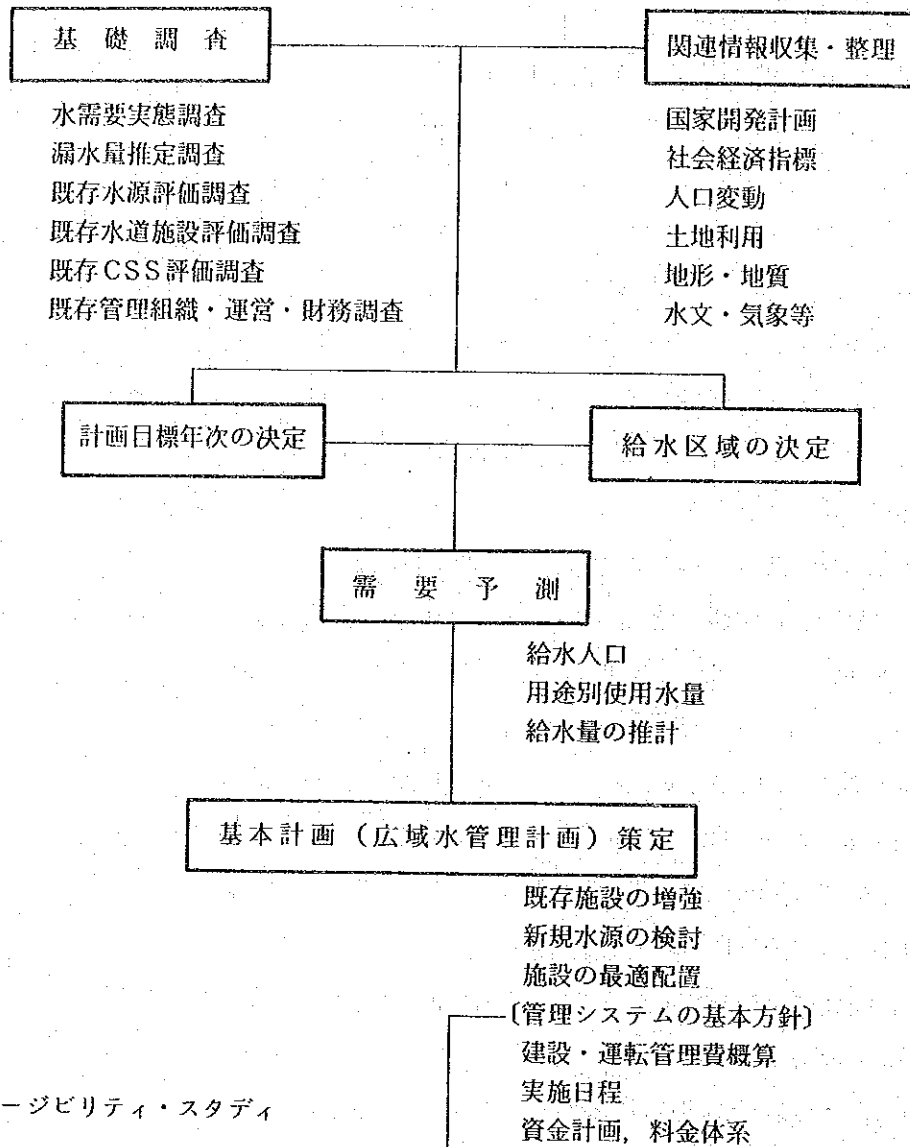
② 維持管理の状況から判断して、WASAの技術及び事務能力はかなり高いと思われるので、調査に当たっては十分協議し、また、協力を求めることが望ましい。

### (5) その他

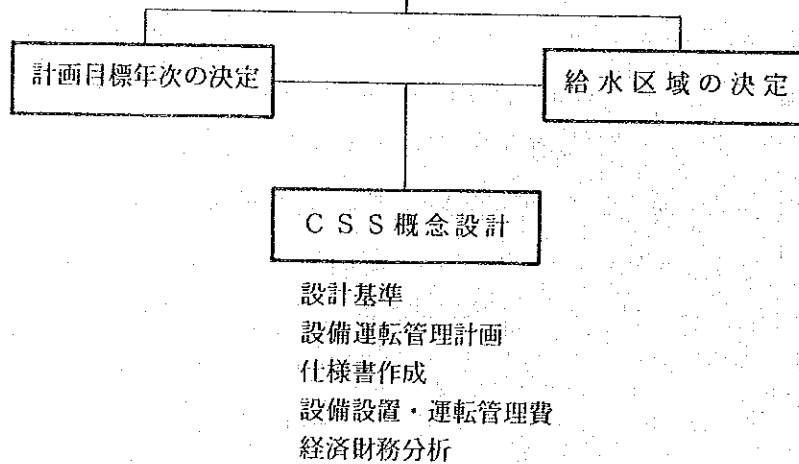
TT国の現在の水道料金は基本料金のみで、WASAでは各戸メーター設置により、料金体系を従量制に変更する予定にある。経営改善はもとより、需要者の節水意識の高揚は渇水対策の一助ともなるので、検針制度、料金徴集方法等、新料金体系以降に関し、適切な助言、提案を行うことが望ましい。

## 本格調査のフロー

### I. 基本計画



### II. フィージビリティ・スタディ



## 添 付 資 料：

1. S/W
2. M/M
3. トリニダッド・トバゴ国からの要請書 (TOR)
4. 持帰り資料リスト
5. 面談者リスト
6. トリニダッド・トバゴ行政区一覧
7. トリニダッド島水道地図
8. CSS の概要
9. 1989年度 WASA 開発予算内訳
10. 渇水に関する新聞記事





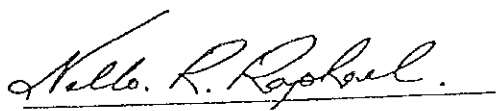
## 1. S/W

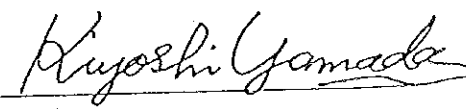


添付資料 1. S/W

SCOPE OF WORK  
FOR  
THE STUDY  
ON  
THE IMPROVEMENT OF WATER SUPPLY SUPERVISORY SYSTEM  
IN  
TRINIDAD AND TOBAGO  
AGREED UPON BETWEEN  
THE GOVERNMENT OF  
THE REPUBLIC OF TRINIDAD AND TOBAGO  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

PORT OF SPAIN, MAY 31, 1989

  
Mr. NELLO RAPHAEL  
ECONOMIC ADVISER TO  
THE PRIME MINISTER  
(TECHNICAL COOPERATION UNIT  
OF PRIME MINISTER'S OFFICE)

  
Dr. Kiyoshi YAMADA  
LEADER OF  
PRELIMINARY SURVEY TEAM  
JAPAN INTERNATIONAL  
COOPERATION AGENCY

## I. INTRODUCTION

In response to the request of the Government of the Republic of Trinidad and Tobago (hereinafter referred to as "the Government of Trinidad and Tobago"), the Government of Japan has decided to conduct the Study on the Improvement of Water Supply Supervisory System in Trinidad and Tobago (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with authorities of the Government of Trinidad and Tobago.

The present document sets forth the Scope of Work with regard to the Study.

## II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. to formulate the Master Plan for a comprehensive water supply supervisory system in Trinidad and Tobago,
2. to conduct the Feasibility Study on the improvement and expansion of the existing water supply Central Supervisory System,
3. to effect technology transfer to Trinidad and Tobago counterpart personnel in the course of the Study

## III. STUDY AREA

The Study area shall cover the islands of Trinidad and Tobago.

## IV. SCOPE OF THE STUDY

The Study comprises two phases and includes the following:

### 1. Phase I: Master Plan Study

#### (1) Data collection and analysis

- 1) national development policy and plan for water supply sector
- 2) socio-economic parameters
- 3) present and future land use

- 4) topographical and geological maps
- 5) hydrological and meteorological data
- 6) road map and future road construction plan
- 7) information on underground cables, pipes, etc.
- 8) other related data and information

(2) Field survey

- 1) field reconnaissance
- 2) hydrological and meteorological observation
- 3) topographic survey
- 4) route survey
- 5) other related surveys

(3) Review of existing water supply system including the Central Supervisory System (CSS)

- 1) water sources
- 2) facilities
- 3) water supply and demand
- 4) institution and organization
- 5) operation and maintenance

(4) Establishment of basic factors

- 1) target year and goals
- 2) tariff system
- 3) design criteria

(5) Estimation of water demand

(6) Study of available construction materials, labour forces, local contractors and social infrastructures

(7) Formation of Master Plan for a comprehensive water management

- 1) study of alternative plans
- 2) rough estimation of costs for construction, operation and maintenance
- 3) preparation of implementation schedule in stages
- 4) financial and economic evaluation
- 5) identification of appropriate plan including improvement and expansion plan for the CSS

2. Phase II: Feasibility Study

(1) Confirmation of basic factors

- 1) target year and goals
- 2) project areas
- 3) population to be served
- 4) water demand
- 5) design criteria

(2) Preliminary design

(3)Preparation of implementation plan

- 1)procurement plan for construction materials and equipment
- 2)construction plan
- 3)operation and maintenance plan including manpower training programme

(4)Estimation of costs for construction,operation and maintenance

(5)Financial and economic evaluation

(6)Preparation of financial plan

(7)Study of socio-economic impact

(8)Study of community participation

(9)Preparation of implementation programme(IP)

(10)Recommendations

V.STUDY SCHEDULE

The Study will be conducted in accordance with the attached tentative schedule.

VI.REPORTS

JICA shall prepare and submit the following reports in English to the Government of Trinidad and Tobago.

1. Inception Report  
Fifteen(15)copies within one(1)month from the date of the commencement of the Study
2. Progress Report(1)  
Fifteen(15)copies at the end of the first field survey.
3. Interim Report  
Thirty(30)copies at the beginning of the second field survey.
4. Progress Report(2)  
Fifteen(15)copies at the end of the second field survey.
5. Draft Final Report  
Fifteen(15)copies within three(3)months after the second field survey. The Government of Trinidad and Tobago and/or Water and Sewerage Authority(hereinafter referred to as "WASA")present their comments on the report to JICA through the Japanese Embassy within one(1)month after receipt of the Draft Final Report.

## 6. Final Report

Forty(40)copies within two(2)months after receipt of the comments on the Draft Final Report. All comments given by the Government of Trinidad and Tobago and/or WASA will be compiled in the preparation of the Final Report.

## VII. UNDERTAKINGS OF THE GOVERNMENT OF TRINIDAD AND TOBAGO

1.To facilitate smooth conduct of the Study,the Government of Trinidad and Tobago shall take necessary measures:

- (1) to secure the safety of the Study Team
- (2) to permit the members of the Study team to enter, leave and sojourn in the Republic of Trinidad and Tobago for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees
- (3) to exempt the members of the Study Team from taxes, duties and any other charge on equipment, machinery and other materials brought into Trinidad and Tobago for the conduct of the Study
- (4) to exempt the members of the Study team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Study team for their services in connection with the implementation of the Study
- (5) to provide necessary facilities to the Study team for remittance as well as utilization of the funds introduced into Trinidad and Tobago from Japan in connection with the implementation of the Study
- (6) to secure permission for entry into private properties or restricted areas for the conduct of the Study within laws and regulations in force in the Republic of Trinidad and Tobago
- (7) to secure permission to take all data and documents (including aerial photographs)related to the Study out of Trinidad and Tobago to Japan by the Study team
- (8) to provide medical services as needed.Its expenses will be chargeable on members of the Study team

2.The Government of Trinidad and Tobago shall bear claims,if any arise ,against the members of the Study team resulting from,occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study,except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Study team.



3. WASA shall act as counterpart agency to the Study team and also as coordinating body in relation with other governmental and non-governmental organization concerned for the smooth implementation of the Study
4. WASA shall, at its own expense, provide the Study team with the following, in cooperation with other relevant organizations:
  - (1) available data and information related to the Study
  - (2) counterpart personnel
  - (3) suitable office space with necessary equipment
  - (4) credentials or identification cards, if necessary
  - (5) appropriate numbers of vehicles with drivers

#### VIII. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. To dispatch, at its own expense, the Study team to the Republic of Trinidad and Tobago
2. To effect technology transfer to the Trinidad and Tobago counterpart personnel in the course of the Study.

#### IX. CONSULTATION

JICA and WASA shall consult each other in respect of any matter that may arise from or in connection with the Study.



APPENDIX

TENTATIVE SCHEDULE

| ITEM                               | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| MONTH                              |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| STUDY IN<br>TRINIDAD<br>AND TOBAGO |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| STUDY IN<br>JAPAN                  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| REPORT                             |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |

(REMARKS) IC/R : Inception Report P/R : Progress Report  
IT/R : Interim Report DR/R : Draft Final Report



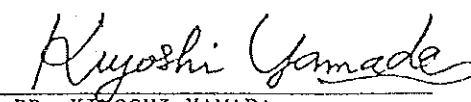
## 2. M/M



MINUTES OF MEETING  
ON  
SCOPE OF WORK  
FOR  
THE STUDY  
ON  
THE IMPROVEMENT OF WATER SUPPLY SUPERVISORY SYSTEM  
IN  
TRINIDAD AND TOBAGO  
AGREED UPON BETWEEN  
WATER AND SEWERAGE AUTHORITY  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

PORT OF SPAIN, MAY 31, 1989

  
EMILE W. WARNER  
EXECUTIVE DIRECTOR  
WATER AND SEWERAGE AUTHORITY

  
DR. KIYOSHI YAMADA  
LEADER OF  
PRELIMINARY SURVEY TEAM  
JAPAN INTERNATIONAL  
COOPERATION AGENCY

*Handwritten: H.Y.*  
Japan International Cooperation Agency (hereinafter referred to as "JICA"), at the official request of the Government of the Republic of Trinidad and Tobago, dispatched the Preliminary Survey Team (hereinafter "The Team"), headed by Dr. Kiyoshi Yamada, to Trinidad and Tobago from May 22 to May 31, 1989, to determine the Scope of Work for the Study on the Improvement of Water Supply Supervisory System in Trinidad and Tobago (hereinafter referred to as "the Study").

The Team held a series of discussions with the concerned authorities of the Government of the Republic of Trinidad and Tobago, in particular with Water and Sewerage Authority (hereinafter referred to as "WASA") and agreed on the Scope of Work for the Study. The list of participants to the meeting is at Appendix I.

This document sets forth the main points discussed during the above period:

1. The Team explained that the Study will be carried out within the framework of Development Survey Programme under the technical cooperation scheme of Japanese Government.
2. The Team explained that the Study will cover monitoring system for distribution pipe lines in order to establish more effective water supply supervisory system in Trinidad and Tobago.
3. Regarding the Master Plan Study, the Team expressed its strong concern on the planned Water Resources Development Master Plan Study, which is expected to be carried out by other consulting firms, and requested WASA take appropriate measures to avoid overlap in items of the Study. Both sides agreed that the Japanese Study Team should conduct the Study as envisaged in the Scope of Work.
4. In reference to IV,1,(3),1) of the Scope of Work, both sides agreed that review of water sources will be focussed on the existing water sources by utilising available data and reports.
5. In reference to IV,1,(5), both sides agreed that projection of water demand should mainly be conducted on the basis of officially published data and information.
6. Regarding the existing Central Supervisory System (CSS), both sides agreed that considering the obsolescence of the equipment, new hardware and software could be introduced, if necessary. The Study should include the formulation of basic design for software and preparation of general specification for hardware, together with a phased implementation programme.
7. With reference to VIII,2, it was agreed that it would be beneficial for an appropriate number of WASA Engineers to visit Japan as part of the technology transfer. The Team explained that application forms A2 and A3 are obtainable at the Japanese Embassy and requests should be processed through this official channel.

*Handwritten: H.Y. 89-05-31*

### 3. トリニダード・トバゴ国からの要請書 (TOR)





W A T E R   A N D   S E W E R A G E   A U T H O R I T Y

PROJECT PROPOSAL FOR  
JAPANESE DEVELOPMENT PROGRAMME

1. PROJECT TITLE

Feasibility study for the expansion of the Remote Sensing Information System.

2. INTRODUCTION

A segment of the water system is now monitored by an Electronic Central Supervisory System comprising of a central computer, remote terminal units, voice communication system and data radio system. The system provides real time information on flows, levels, pressures and pump status. It is proposed to expand the Central Supervisory System throughout Trinidad and Tobago.

3. BACKGROUND

3.1 Location

The area to which the study applies covers the islands of Trinidad and Tobago. The island of Trinidad is approximately 9km of the northeastern corner of Venezuela on the South American Continent. It is located about 10 degrees north of the equator between 61 and 62 degrees west longitude and is the southernmost island in the Caribbean Archipelago.

The sister island of Tobago lies northeast of Trinidad and is separated by approximately 35km of sea. It is situated about 11 degrees north of the equator at about 60 degrees west longitude.

3.2 Topography

Trinidad is approximately 102km long by 77km wide with an area of about 4,828 sq.km. The physical features include three mountain ranges: the Northern Range, which runs the full length of the northern coast; the Central Range which runs diagonally across the island in a north-easterly direction, and finally, the Southern Range which follows the southern coast in a broken line.

The Northern Range is an area of rugged topography, steep slopes and peaks rising to over 914 metres. The area between the Northern and Central Range is flat and comprises about 1050 sq.km. In the rest of the island, that is, between the Central and Southern Ranges, the topography is broken and represents an irregular pattern of partly flat, partly

rugged and mildly undulating terrain.

Tobago is approximately 52km long by 18km wide with an area of about 300 sq.km. The topography is broken with a chain of peaks running along the center of the island. The highest point in the main ridge is about 550 metres above mean sea level.

### 3.3 Climate

The islands have a humid tropical climate with uniformly high temperatures all year round (average approximately 26.6°C) and there are two clearly defined seasons - the dry season and the wet season. Rainfall is generally heavy in excess of 200mm per annum, but varies considerably with location and season, being heaviest in the wet season (June to November) and in the eastern half of Trinidad and the mountainous areas of the country.

### 3.4 Population

The population of Trinidad and Tobago (1987) was estimated to be 1.2 million with Tobago accommodating 44,000 persons.

### 3.5 The Water and Sewerage Authority (WASA)

The Water and Sewerage Authority (WASA) of Trinidad and Tobago is the sole agency responsible for the development of water resources, the conservation and proper use of water, and the collection, treatment and disposal of sewage. For administrative purposes the country is divided into three regions (North, South and Tobago), eight districts and twenty-six distribution areas.

### 3.6 Existing Systems

#### 3.6.1 Water

The average annual water production for 1987 was 659,000 m<sup>3</sup>/d and was obtained from 95 separate water supply sources in Trinidad and Tobago. These sources range in size from rural intakes supplying less than 45 m<sup>3</sup>/d to the Caroni Water Treatment Plant which can produce up to 272,700 m<sup>3</sup>/d.

Approximately 65% of the water produced is obtained from four large surface sources (Hollis, Navet, North Oropouche and Caroni/Arena) and together with the other surface sources account for 75% of all the water produced. The remainder (25%) is obtained from ground sources comprising several well fields and many individual wells. The degree of treatment applied at individual sources varies with water quality. They represent water that may need only disinfection to water that requires full treatment of coagulation, sedimentation, filtration, disinfection or other forms specialized treatment.

There is a well integrated network of pipeline forming the transmission and distribution system and these are linked to over 100 distribution storage reservoirs. These reservoirs range in size from 45,500 m<sup>3</sup> to less than 45m<sup>3</sup>. They are generally located at ground level in elevated areas to serve the many operational pressure zones as a result of the topography. The system has numerous pumps and is dependent on a reliable electric power supply to give continuous service.

It is estimated that 75% of the population is served by direct house connection on the premises. Twenty percent receive their supplies from public standpipes and the remainder is dependent on rain, rivers, springs etc.

#### 3.6.2 Sewerage

The Water and Sewerage Authority operates three (3) central sewerage schemes in Port of Spain, San Fernando and Arima to which 25,000 households are connected. Another 25,000 households are connected to smaller WASA systems and to over 100 private wastewater collection, treatment and disposal systems.

### 4. PROJECT DESCRIPTION

#### 4.1 Existing

The period 1977-1980 saw a rapid expansion in water supply, system expansion and system complexity. To address the tremendous problems in Water operations as regards information and communication WASA installed an Electronic Central Supervisory System with the following objectives:

- (a) to improve the flow of information for quicker decision makings and hence enhance the management of the water system;
- (b) to effectively monitor plant operations, and the transmission and distribution systems;
- (c) to optimize the use of resources like manpower, electricity, chemicals and water itself;
- (d) to provide a more efficient service to the customer and to improve the overall performance of WASA;
- (e) to enhance the planning functions through the storage and retrieval of data.

The existing Central Supervisory System (CSS) consists of the following elements:

- (a) a central computer (DEC PDP-11/34) with peripheral devices at the Authority's Head Office;
- (b) Remote Terminal Units (RTU's) at various location of the water supply system;
- (c) a communication link between the computer and the RTUs;
- (d) a voice radio communication from central supervision to plant.

The voice communication system forms part of WASA's wider voice radio system and is equipped with two channels and a repeater station.

There are now 12 RTUs in place and they are located at the Caroni Water Treatment Plant, Arena Pumped Storage Complex and at several other installations which includes reservoirs and booster pumping stations. These remote sites gather analogue and digital information such as flows (pipelines and rivers), levels (reservoirs, channels), pressures, pump status and power failures providing real time displays of the water system status.

The three basic functions provided by the Central Supervisory System can be described as follows:

- (a) alarm notification - an alarm condition occurs when the value of an analog point falls outside its upper and lower limits or when a digital alarm status is activated;
- (b) generation of a historical database - This contains a daily history of all the analog points in the system which may be plotted on an x-y plotter or a colour CRT;
- (c) control functions - These are process control tasks which provide the following:
  - (i) analog and digital outputs at various stations;
  - (ii) feedback loop using a tank level to control pumping pattern in the system by altering valve position;
  - (iii) remote control of pumps and valves.

#### 4.2 Expansion

The existing Central Supervisory System (CSS) has impacted favourably on the management of the elements of the water system that it now assists in monitoring. WASA in recognition of the benefits proposes to expand the CSS to other installations and segments of the water system and hence:

- (a) broaden the information and communication base for monitoring of the water system and thus further enhancement of its management;
- (b) to further optimize the use of resources and reduction in operational cost;
- (c) to achieve better customer satisfaction as a result of the expected higher level of efficiency throughout the system;
- (d) in the longer term to provide an environment for technical computation which would facilitate designs and modelling, distribution system analysis, and also assist in leakage control and development of schedules for preventive maintenance.

#### 4.3 Scope/Terms of Reference

It is proposed therefore, that a feasibility study be undertaken for expansion of the Remote Sensing Information System in WASA and the scope/terms of reference of the project will be as follows:

- (a) review of the existing facilities, Central Supervisory System (CSS) for collection and processing of technical data and make recommendation for its improvement;
- (b) conduct a study for the expansion of the existing CSS to strategic installation and points in the distribution system throughout Trinidad and Tobago to meet optimum needs;
- (c) identification of feasible options and full evaluation of their economic and technical implications;
- (d) establishment of priorities;

- (e) proposals for a programme of improvements and development;
- (f) provision of cost estimates;
- (g) clear identification of components hardware and software requirements and training needs;
- (h) make recommendation for the management of the system with respect to maintenance, spares, skills, manpower, and financial resources.

#### 4.4 Implementation

WASA is prepared to have the Feasibility Study begin as soon as possible and estimate that a consultant will be required for a period of three months.

#### 4.5 Assistance

No other Government or International Organization has been contacted nor is contact being contemplated with respect to the subject project.

#### 4. 持帰り資料リスト





添付資料4. 持帰り資料リスト

I. GENERAL INFORMATION ..... WASA より入手

1. WASA Organization Structure
2. Approved Development Programme 1989

II. TECHNICAL INFORMATION ..... WASA より入手

1. Central Supervisory System
  - (1) Existing System
  - (2) Status Report ('85.02.04)
  - (3) Status Report ('87.12.01)
  - (4) Memorandum (Werner Schnitgger, '78.11.10)
  - (5) Report (Draft)
  - (6) Annual Report 1988
  - (7) Drawings
  - (8) List of RTU Instrumentation
  - (9) Software Operations Manual and Documentation
  - (10) Inventory
  - (11) Location of RTU
2. Water Demand
  - (1) The Present Status of Water Supply and Demand
3. Water Production
  - (1) Summary for the Year 1987
  - (2) Summary for the Year 1988
  - (3) Water Supply Subdivision Monthly Report for April, 1988
4. Water Quality
  - (1) Statistical Analysis of Water Sources
  - (2) Bacteriological Report
5. Others
  - (1) Water Study (1970.09.23)
  - (2) Integration of the Caroni Water Supply into the Trinidad System for the Caroni-Arena Water Supply Project (1974.12)
  - (3) Caroni-Arena Water Supply Project-Final Report (1983.08)
  - (4) The Water System Balance in Trinidad (1985.06)

- (5) Technical Assistance by Wessex Water (1988.08)
- (6) The Present and Future Supplies and Demand of the Leeward Section, Tobago

### III. ADMINISTRATIVE AND FINANCIAL INFORMATION

----- WASA より入手 ただし 1. (1)は日本大使館より入手

#### 1. Policy

- (1) Budget Speech and Taxation Measures
- (2) WASA Strategic Plan 1989-1991
- (3) Self Sufficiency WASA -1991
- (4) Policy for the Effective Management and Control of the Operations and Maintenance Dept. (OMD)
- (5) The Re-Organisation of the OMD
- (6) Re-Organisation Phase II
- (7) Rationalisation of the Distribution Area Offices

#### 2. Law and Regulation

- (1) The Water and Sewerage Act

#### 3. Financial Condition

- (1) Approved Estimates—1989, Income and Expenditure
- (2) WASA Estimates—1988, Revenue and Expenditure
- (3) Water and Wastewater Rates

#### 4. Othres

- (1) WASA Draft Text fo Annual Reprot 1987
- (2) Centre for Manpower Development 1988
- (3) Centre for Manpower Development 1989
- (4) OMD 1986 Ammual Report
- (5) Quality Control Dept. Annual Report for 1988
- (6) North Region Annual Report 1988
- (7) Tobago Region 1988 Year End Report
- (8) Tobago Region Monthly Report April 1989
- (9) Water Supply Sub-Division 1989 First Quarter Report
- (10) Management of Water Distribution Systems
- (11) CBWMP —Management of Water Distribution Systems
- (12) CBWMP —Systems Mapping
- (13) CBWMP —Fault Reporting and Tracking
- (14) CBWMP —Quality control in Water Production and Distribution

#### IV. RELEVANT DATA · INFORMATION AND STUDIES

1. General ..... (1)、(2)は Land & Survey Dept.より入手  
(3)～(5)は WASA より入手

(1) Topographic Maps

|                    |           |           |
|--------------------|-----------|-----------|
| — Topographic Maps | 1/25,000  | 38 sheets |
|                    | 1/75,000  | 4 sheets  |
|                    | 1/150,000 | 1 sheets  |
| — Tobago           | 1/25,000  | 3 sheets  |
|                    | 1/50,000  | 1 sheets  |
| — Port of Spain    | 1/10,000  | 1 sheets  |
| — San Fernando     | 1/ 5,000  | 1 sheets  |
| — Arima            | 1/10,000  | 1 sheets  |

(2) Geologic Maps

|                    |          |          |
|--------------------|----------|----------|
| — Topographic Maps | 1/50,000 | 8 sheets |
|--------------------|----------|----------|

(3) Surface Water Report 1984 & 1985

(4) Groundwater Report 1984 & 1985

(5) Climatic Report 1984 & 1985

2. Socio-Economic Parameter

..... (1)～(5)は日本大使館から入手

(6)～(8)はCentral Statistical Officeより入手

(1) Review of Economy 1988

(2) Restructuring for Economic Independence

Draft Medium Terms Macro Planning Framework 1989-1995

(3) Development Co-operation 1987 Report

(4) Inter-American Development Bank Annual Report 1988

(5) Economic and Social Progress in Latin America 1988 Report

— Special Section : Science and Technology

(6) Population and Housing Census 1980

— Volume VII Households

— Population by Sex and Number of Households at Locality and  
Town/ village Level for Major/ Minor Divisions

— Volume I Part II Maps Showing Enumeration Districts

(7) Annual Statistical Digest 1987

(8) Household Budgetary Survey Bulletin (1989.3)

- 3. Relevant Plans and Studies ..... 計画・再建省より入手
  - (1) National Physical Development Plan
    - Vol.1 Survey & Analysis
    - Vol.2 Strategies & Proposals
- 4. Sanitary Condition
  - (1) Sewerage Facilities (1968.09.23) ..... WASAより入手
  - (2) Reported Cases of Certain Diseases ..... 保健省より入手

## 5. 面談者リスト



添付資料5. 面談者リスト

I. Water and Sewerage Authority (WASA)

1. Mr. Emile W. Warner  
Executive Director
2. Mr. Merel-Vyn Sankar Alli  
Technical Director
3. Mr. Nazir Ali Nabbie  
Deputy Technical Director
4. Mr. Emmanuel Romain  
Chief Engineer, Operations and Maintenance
5. Mr. T. Tota-Maharah  
Chief Engineer, Major Maintenance and Transport
6. Mr. Charles Tam  
Engineer III, Systems
7. Mr. Karl Narine  
Engineer II, Digital Electronics and Instrumentation
8. Mr. Eutace Ferguson  
Planning Engineer
9. Mr. M. Quashie  
Regional Engineer, North
10. Mr. Haydn Blaize  
Regional Engineer, Tobago
11. Mr. Campbell  
District Engineer, Tobago



## II. Ministry of settlements and Public Utilities

1. Ms. Pamela Nicholson  
Minister
2. Mr. Elias Soogrim

## III. Ministry of External Affairs

1. Mr. Louis Wiltsluice  
Director, Division of Science & Technical Co-operation
2. Ms. Sundra Honore -Braithwaite  
Foreign service Officer II
3. Mr. Keith Kerwood  
Foreign service Officer I

## IV. Ministry of Planning and Modilization

1. Mr. Carlyle Greaves  
Permanent Secretary
2. Ms. Dorothy Sookdeo  
Acting Director, Project Planning and Programming
3. Mr. G. Hoontin  
Town and Country Plannnig Division

#### V. Office of the Prime Minister

1. Mr. Nello R. Raphael  
Economic Adviser to the Prime Minister
2. Ms. Sandra Caruth  
Technical Cooperation Unit
3. Ms. Lynn Bronx  
Technical Cooperation Unit

#### VI. Central Statistical Office

1. Mr. Daniel Deen  
Head of Population and Census Unit
2. Ms. Shirley Chistian-Maharaj  
Population and Census Unit



## 6. トリニダード・トバゴ行政区一覧



添付資料6. トリニダード・トバゴ行政区一覧

(特別都市)

- Port of Spain
- San Fernando
- Arima Borough
- Point Fortin Borough

(州・区)

- Sr. George Country
  - Diego Martin Ward
  - St. Anns "
  - Tacarigua "
  - Arima "
  - Blanchisseuse "
  - San Rafael "
- Caroni Country
  - Montserrat Ward
  - Chaguanas "
  - Cunupia "
  - Couva "
- Nariva Country
  - Cocal Ward
  - Charuma "
- Mayaro Country
  - Guayaguare Ward
  - Trinity "
- St. Andrew Country
  - Valencia Ward
  - Matura "
  - Tamana "
  - Manzanilla "
  - Turure "
- St. David Country

- Toco Ward
- Victoria Counrty
  - Ortoire Ward
  - Naparima "
  - Pointe • A • Pierre "
  - Moruga
  - Savana Grande "
- St.Patrick Country
  - Siparia Ward
  - Erin "
  - La Brea "
  - Cedros "
- Tobago

## 7. トリニダード島水道地図

-North West

-North East

-South West

- South East



