

M I N E R A L I S A T I O N   O F   S E W A G E

With Particular Reference to the  
Problems encountered within the  
Sewerage Catchment of the Cape  
Town City Council

A THESIS PREPARED AND SUBMITTED IN  
PART FULFILMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF M.Sc. (CIVIL  
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by

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S Y N O P S I S

Section 21(7) of the Water Act of 1956 defines a water-borne sewerage scheme as an industrial use of water and as such sewerage schemes must conform to the provisions of the Act.

This Thesis presents a summarised discussion of the requirements of the Water Act (No. 54 of 1956) in regard to the use of water for industrial purposes; the problems of treating sewage effluents to the standards presented by State Regulations; the difficulties in finding suitable markets for use of effluents resulting from pollution by dissolved inorganic solids; the methods used to trace this pollution including, closed circuit television; the results of investigations in the Catchment of the Athlone Sewage Treatment Plant; and concludes with observations, conclusions and recommendations for reducing the mineral loads in the sewers of the areas contributing to the Athlone Sewage Treatment Works.

The paper is accompanied by eight tables, thirteen photographs, thirteen graphs, one map, and a list of references.

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All the investigations reported were carried out as part of the normal duties of the personnel concerned.

ABBREVIATIONS USED IN THIS PAPER

k1	=	kilolitres
mg/l	=	milligrams per litre
Ml	=	Megalitres
m <sup>3</sup> /min	=	cubic metres per minute
TDS	=	total dissolved <u>inorganic</u> solids
M.S.L.	=	mean sea level at Table Bay Docks
m.e./litre	=	milli-equivalents/litre

Chapter 1:            INDUSTRIAL USE OF WATER

The inclusion of the Water Act<sup>(1)</sup>, of 1956, in the Statute Book of the Republic of South Africa has provided legislation which is primarily intended to conserve the country's water resources.

In a country such as the Republic, with such vast areas of land subject to periodic droughts of long duration, the most efficient use of water resources is essential.

This is more difficult in that the rainfall is usually of short duration, and the run-off rapid; the major storage schemes have thus to rely on their replenishment from erratically occurring precipitation.

The Water Act envisages control over extraction from rivers; it requires that such water as is extracted from a river is returned to the river after use in a state that does not render it less fit for subsequent re-use.

The Act lays down that the State may frame regulations for the control of waters returned to rivers after use for industrial purposes.

"Use of Industrial Purposes", in relation to water, means use for manufacturing, mechanical or mining purposes, or for the generation of power, or use by the South African Railways and Harbours Administration for railway purposes and includes use for domestic purposes or for the purpose of waterborne sanitation or for the watering of stock or of streets and gardens in so far as may be incidental to use for industrial purposes"<sup>(2)</sup>

This definition is far reaching and in terms of Section 21(7) of the Act, any local authority using water for purification or disposal of sewage is deemed to use such water for industrial purposes.

Section 22(1) enables any local authority, subject to ministerial permission, "to use effluents for any approved purposes, or dispose of such effluent for use by any person, or discharge such effluent into a public stream".

The Regulations prescribed by Government Notice No. R553 dated 5th April, 1962, <sup>(3)</sup> (included in Table 1) specify limits in regard to various parameters describing a degree of pollution and they have been subject to much criticism in regard to their severity.

Some of the parameters are virtually unattainable; one of these is the limit imposed for faecal coli; i.e. "the waste water or effluent shall contain no typical (faecal) coli per 100 millilitres". It is doubtful whether any sewage treatment plant established in the Republic could comply with this requirement and tertiary treatment must be introduced.

One must not decry high standards as such could be relaxed, in special circumstances; on the other hand it would be difficult to enhance low standards if such were initially introduced.

In the light of effective re-use of water, it is probable that the standards will have to be increased.

However, one parameter with which all effluents must comply is that relating to the mineral uptake of water during its period of use; this is specified in the "general standard" as not to exceed an uptake of 500 mg/l over the intake water.

It is this aspect of pollution of our water resources - MINERALISATION - with which this thesis is concerned.

The author will endeavour to show that mineralisation of water in its use for industrial purposes - including its use for domestic purposes - is of such great importance that all water users must take effective steps to reduce the discharge of large quantities of mineral salts with their effluents.

Chapter 2:COMPARISON OF STATE AND LOCAL  
AUTHORITY REQUIREMENTS FOR  
DISCHARGE OF INDUSTRIAL EFFLUENTS.

Government Notice R553, dated 5th April, 1962<sup>(3)</sup> lays down quality standards to which "waste water or effluent produced by or resulting from the use of water for industrial purposes shall conform after purification".

The more stringent standard - the "Special Standard" - is applicable to waste water or effluents produced in catchments draining to some 73 rivers specified in the schedule attached to Government Notice R553.

The lower standard - the "General Standard" is applicable to all the main cities and Table 1 compares this standard against the requirements of Johannesburg and the Reef Towns, Pretoria, Durban, Bellville, Cape Town (including Goodwood, Parow and Milnerton), East London and Port Elizabeth.

Table 2 comprises the Cape Town Municipal Drainage and Sewerage Regulations promulgated on 11th June, 1971, as Provincial Notice 575/71, and relevant forms.

It will be seen that there are many similarities between criteria adopted by the local authorities: while these may be coincidental it is the author's opinion that the figures have largely been based on limits imposed outside South Africa and that they are not truly relevant to problems affecting re-use of effluents. No doubt in the course of time, experience, will force drastic revisions and more stringent standards.

For example, Cape Town's limit for total dissolved inorganic solids - 2000mg/litre - is far too high and from experience gained in the twelve months since the regulations were promulgated it should at least be halved; it is more than likely

The Administrator has approved the subjoined regulations framed by the Municipal Council of Cape Town.

**CAPE TOWN MUNICIPALITY: DRAINAGE AND SEWERAGE REGULATIONS**

*Definitions*

1. In these regulations, unless the context otherwise indicates —

“Building Regulations” means the regulations promulgated under Provincial Notice 255 dated 15 July 1920, as amended;

“City Engineer” means the City Engineer of the City of Cape Town, any other person lawfully acting in that capacity, and any employee of the Council duly authorised thereto by such City Engineer or person so acting;

“Council” means the Municipal Council of Cape Town;

“cycle” means any period of six months commencing on the first day of January or the first day of July in any year;

“domestic purposes” means the use of any water-closet, urinal or ablution facilities or the operation of any cafeteria or canteen solely for the use of persons employed at the premises on which such cafeteria or canteen is situate;

“fixed date” means the date corresponding numerically to and three months after the date on which these regulations are promulgated;

“industrial effluent” means any liquid, whether or not containing matter in suspension, which is given off in the course of, or as the result of —

(i) any activity, other than domestic purposes, carried on in trade premises, and

(ii) the operation on any premises of any air-conditioning plant, machinery or installation which requires the use of water, unless such liquid is, before it is discharged from such premises, used for domestic purposes;

“occupier”, in relation to any premises, means —

(i) the person having the management or control of any business conducted on such premises, or the principal, superintendent or other person in charge of any institution, including any charitable, educational or similar institution, carrying on any process, handicraft or occupation on such premises, or

(ii) in the case of any premises in respect of which there are two or more persons referred to in paragraph (i) or in any case which is not dealt with in paragraph (i) or in which the address of the person referred to therein is not known to the Council, the owner of such premises;

“owner” shall bear the meaning assigned thereto by section 164 of the Municipal Ordinance (Ordinance 19 of 1951, as amended);

“premises” means any land separately owned together with any buildings thereon;

“sewage” includes industrial effluent;

“Town Clerk” means the Town Clerk of the City of Cape Town, any other person lawfully acting in that capacity, and any employee of the Council duly authorised thereto by such Town Clerk or person so acting;

“trade premises” means a factory as defined in section 3 of the Factories, Machinery and Building Work Act, 1941 (Act 22 of 1941), as amended from time to time, and

any other word or term defined in section 2 of the Municipal Ordinance (Ordinance 19 of 1951), shall bear the meaning assigned thereto in the said section as amended.

Die Administrateur het sy goedkeuring geheg aan die volgende regulasies opgestel deur die Munisipale Raad van Kaapstad.

**MUNISIPALITEIT KAAPSTAD: REGULASIES INSAKE DREINERING EN RIOLERING**

*Woordbepaling*

1. In hierdie regulasies, tensy uit die samehang anders blyk —

beteken “bedryfsperseel” ’n fabriek soos omskryf in artikel 3 van die Wet op Fabriek, Masjinerie en Bouwerk, 1941 (Wet 22 van 1941), soos van tyd tot tyd gewysig;

beteken “Bouregulasies” die regulasies afgekondig by Provinsiale Kennisgewing 255 van 15 Julie 1920, soos gewysig;

het “eienaar” die betekenis daaraan geheg by artikel 164 van die Munisipale Ordonnansie (Ordonnansie 19 van 1951, soos gewysig);

beteken “huishoudelike doeleindes” die gebruik van enige spoelkloset, urinaal of wasgeriewe of die gebruik van enige kafeteria of verversingslokaal uitsluitend vir die gebruik van persone in diens by die perseel waarop sodanige kafeteria of verversingslokaal geleë is;

beteken “kringloop” enige tydperk van ses maande wat op die eerste dag van Januarie of die eerste dag van Julie in enige jaar begin;

beteken “nywerheidsuitvloei” enige vloeistof, ongeag of dit stowwe in suspensie bevat of nie, wat afgeskei word in die loop, of as gevolg van —

(i) enige werksaamheid, uitgesonderd huishoudelike doeleindes, wat op bedryfspersele onderneem word, en

(ii) die gebruik op enige perseel van enige lugversorgingsinstallasie, masjinerie of installasie wat die gebruik van water vereis, tensy sodanige vloeistof, voordat dit van sodanige perseel afgevoer word, vir huishoudelike doeleindes gebruik word;

beteken “okkupeerder” in verband met enige perseel —

(i) die persoon wat enige saak wat op sodanige perseel gedryf word, bestuur of beheer, of die hoof, superintendent of ander persoon belas met die toesig oor enige inrigting, met inbegrip van enige liefdadigheids-, opvoedkundige of dergelike inrigting, wat enige bewerking, handwerk of bedryf op sodanige perseel onderneem, of

(ii) in die geval van enige perseel ten opsigte waarvan daar twee of meer persone is na wie in paragraaf (i) verwys word of in enige geval wat nie in paragraaf (i) behandel word nie of waarin die adres van die persoon na wie daarin verwys word, nie aan die raad bekend is nie, die eienaar van sodanige perseel;

beteken “perseel” enige grond in afsonderlike eiendom tesame met enige geboue daarop;

beteken “raad” die Munisipale Raad van Kaapstad;

omvat “rioolslyk” nywerheidsuitvloei;

beteken “stadsingenieur” die stadsingenieur van die stad Kaapstad, enige ander persoon wat wettig in dié hoedanigheid optree, en enige werknemer van die raad wat deur sodanige stadsingenieur of persoon wat sodanig optree, behoorlik daartoe gemagtig is;

beteken “stadsklerk” die stadsklerk van die stad Kaapstad, enige ander persoon wat wettig in dié hoedanigheid optree en enige werknemer van die raad wat deur sodanige stadsklerk of persoon wat aldus optree, behoorlik daartoe gemagtig is;

beteken “vasgestelde datum” die datum, numeriek ooreenstemmend met en drie maande na die datum waarop hierdie regulasies afgekondig word;

en het enige ander woord of uitdrukking omskryf in artikel 2 van die Munisipale Ordonnansie (Ordonnansie 19 van 1951), die betekenis daaraan geheg in genoemde artikel, soos gewysig.

### Application of Regulations

2. These regulations shall be additional to and not in substitution for any other regulations made by the Council.

#### Consent Required to Discharge Industrial Effluent

3. (1) As from the fixed date no person shall, without the prior written consent of the Council —

(a) discharge or cause or permit the discharge of industrial effluent directly or indirectly into any sewer, or

(b) increase or cause or permit to be increased the quantity or vary or cause or permit to be varied the nature, content or composition of any industrial effluent so discharged.

(2) Every person requiring the Council's consent in terms of subregulation (1) shall apply therefor on the form obtainable from the City Engineer —

(a) on or before the fixed date in the case of any discharge of industrial effluent in existence immediately prior to the fixed date;

(b) when an application form or plans are submitted to the Council in terms of the Building Regulations in the case of any discharge of or increase or variation in industrial effluent which will result from the erection of a building for which such form or plans are required, unless such form or plans were submitted prior to the fixed date, and

(c) not less than one month prior to the commencement of the discharge of or increase or variation in industrial effluent in any other case,

and shall provide such plans, diagrams, samples and additional information as the City Engineer may require.

(3) The Council may, in its discretion, refuse any application made in terms of subregulation (2) or may grant its consent subject to such terms, conditions and restrictions as it may deem necessary.

(4) The Council may refuse to approve or require the amendment of any application form or plans referred to in subregulation (2) (b) if it is of the opinion that such form or plans conflict in any way with or are calculated to lead to any contravention or evasion of any provision of these regulations or of any term, condition, restriction or requirement imposed in terms thereof.

(5) Notwithstanding the provisions of subregulation (1), but subject to the remaining provisions of these regulations, any discharge of industrial effluent in existence immediately prior to the fixed date may, if an application to continue such discharge has been submitted in accordance with subregulation (2) (a), continue as then in existence until such time as the Council has notified the applicant in writing of its decision regarding such application.

#### Industrial Effluent Charges

4. (1) Whether or not the Council has granted its consent for any discharge of industrial effluent referred to in regulation 3 (1), the occupier of any premises from which such discharge takes place shall, in addition to any other charges provided for in these regulations or in any other law, pay to the Council a charge calculated in accordance with the provisions of this regulation in respect of each cycle, commencing with the first completed cycle to run after the fixed date, during which such discharge takes place, the said charge to be paid within thirty days after the Council has rendered an account therefor.

(2) The said charge shall, subject to the succeeding provisions of this regulation, be the greater of the amounts obtained by applying the following formulae:—

$$V(R + T(\frac{1}{4} + \frac{\text{"OA"}}{150})) - 3\ 300(R + T)S \text{ and}$$

$$V(R + T(\frac{1}{4} + \frac{\text{"COD"}}{1\ 500})) - 3\ 300(R + T)S$$

where

### Toepassing van regulasies

2. Hierdie regulasies is aanvullend tot en nie ter vervanging van enige ander regulasies deur die raad gemaak nie.

#### Toestemming vereis om nywerheidsuitvloeiisel af te voer

3. (1) Met ingang van die vasgestelde datum mag niemand sonder die voorafverkreë skriftelike toestemming van die raad —

(a) nywerheidsuitvloeiisel regstreeks of onregstreeks in enige riool afvoer of laat afvoer of toelaat dat dit daarin afgevoer word nie, of

(b) die hoeveelheid van enige nywerheidsuitvloeiisel aldus afgevoer vermeerder of laat vermeerder of toelaat dat dit vermeerder word nie, of die aard, inhoud of samestelling van enige nywerheidsuitvloeiisel aldus afgevoer, verander of laat verander of toelaat dat dit verander word nie.

(2) Iedereen wat die raad se toestemming ingevolge subregulasie (1) verlang, moet daarom aansoek doen op die vorm verkrygbaar by die stadsingenieur —

(a) voor of op die vasgestelde datum in die geval van enige afvoer van nywerheidsuitvloeiisel wat onmiddellik voor die vasgestelde datum bestaan;

(b) wanneer 'n aansoekvorm of planne ingevolge die Bouregulasies aan die raad voorgelê word in die geval van enige afvoer of vermeerdering of verandering van nywerheidsuitvloeiisel as gevolg van die oprigting van 'n gebou waarvoor sodanige vorm of planne vereis word, tensy sodanige vorm of planne voor die vasgestelde datum voorgelê is, en

(c) minstens een maand voor die begin van die afvoer of vermeerdering of verandering van nywerheidsuitvloeiisel in enige ander geval,

en moet enige planne, diagramme, monsters en verdere inligting verskaf wat die stadsingenieur vereis.

(3) Die raad kan na goeddunke enige aansoek weier wat ingevolge subregulasie (2) gedoen word of kan sy toestemming verleen behoudens die bepalinge, voorwaardes en beperkings wat hy nodig ag.

(4) Die raad kan weier om enige aansoekvorm of planne waarna in subregulasie (2) (b) verwys word, goed te keur of die wysiging daarvan vereis indien hy van mening is dat sodanige vorm of planne op enige wyse bots met, of daarop bereken is om te lei tot enige oortreding of ontduiking van, enige bepaling van hierdie regulasies of van enige bepaling, voorwaarde, beperking of vereiste wat daarkragtens opgelê is.

(5) Ondanks die bepalinge van subregulasie (1), maar onderworpe aan die oorblywende bepalinge van hierdie regulasies, kan enige afvoer van nywerheidsuitvloeiisel wat onmiddellik voor die vasgestelde datum bestaan, indien 'n aansoek om sodanige afvoer voort te sit, voorgelê is in ooreenstemming met subregulasie 2 (a), voortgaan soos dit op dié tydstip bestaan tot tyd en wyl die raad die aanseker skriftelik kennis gegee het van sy beslissing rakende sodanige aansoek.

#### Nywerheidsuitvloeiisegelde

4. (1) Ongeag of die raad sy toestemming gegee het vir enige afvoer van nywerheidsuitvloeiisel waarna in regulasie 3 (1) verwys word, moet die okkupeerder van enige perseel van waar sodanige afvoer plaasvind, benewens enige ander gelde waarvoor in hierdie regulasies of in enige ander wet voorsiening gemaak word, aan die raad 'n vordering, bereken in ooreenstemming met die bepalinge van hierdie regulasie betaal met betrekking tot elke kringloop, beginnende met die eerste voltooide kringloop wat op die vasgestelde datum volg, in die loop waarvan sodanige afvoer plaasvind, en genoemde vordering moet binne dertig dae nadat die raad 'n rekening daarvoor gelewer het, betaal word.

(2) Genoemde vordering is, inderworpe aan die volgende bepalinge van hierdie regulasie, die grootste van die bedrae verkry deur die toepassing van die volgende formules:

$$V(R + T(\frac{1}{4} + \frac{\text{"OA"}}{150})) - 3\ 300(R + T)S \text{ en}$$

$$V(R + T(\frac{1}{4} + \frac{\text{"COD"}}{1\ 500})) - 3\ 300(R + T)S$$

waar

- V equals the total amount of industrial effluent discharged from the premises during the cycle concerned in kl;
- R equals the cost of conveying one kl of sewage;
- T equals the cost of treating one kl of sewage;
- S equals the area of the premises in ha;
- "OA" equals the oxygen absorbed from permanganate by such effluent;
- "COD" equals the chemical oxygen demand of such effluent.

(3) (a) The oxygen absorbed from permanganate and the chemical oxygen demand of industrial effluent shall be the arithmetic average of not less than four samples taken at any time during the cycle concerned and shall be determined in accordance with the "Regional Standards for Industrial Effluent — Methods of Testing" laid down in Government Notice R3208 dated 29 August 1969, as amended.

(b) The occupier of premises shall, if he so requests before any sample taken at such premises is removed therefrom, be supplied with one half of such sample.

(4) The costs of treating and conveying one kl of sewage shall be determined by the City Engineer and shall be based on the actual cost to the Council during the preceding calendar year of treating sewage at the Council's sewage works at Athlone and of conveying sewage respectively.

(5) The City Engineer shall determine the total amount of industrial effluent discharged from the premises during each cycle and shall, for the purposes of such determination —

(a) in any case in which industrial effluent and other sewage are measured together, make such allowance as he may deem equitable for such other sewage;

(b) in any case in which the amount of sewage or industrial effluent discharged from the premises is not directly measured —

(i) base such determination on the amount of water used at the premises during the cycle concerned, after making such allowance as he may deem equitable in respect of water used for domestic purposes or irrigation, lost to the atmosphere or present in the articles produced at the premises;

(ii) if industrial effluent is discharged from the premises at more than one point, allocate the said amount of water to the points of discharge as accurately as is possible.

(c) in any case in which a measuring device is read on dates not corresponding with the completion or commencement of a cycle, allocate the periods to which the measurements relate to the cycles within which the greater portion of such periods fall or, if any such period falls equally within two cycles, to such cycle as he deems most appropriate;

(d) in any case in which a measuring device is proved to be defective, but subject to the provisions of subregulation (8), make due allowance for such defect;

(e) in any case in which the discharge commences during a cycle, determine the date on which such discharge shall be deemed to have commenced.

(6) The City Engineer may direct that one or both of the formulae referred to in subregulation (2) be dispensed with in any case in which he is of the opinion that the method for evaluating the strength of industrial effluent specified in such formula or formulae will not reflect the strength of the effluent concerned accurately.

(7) The City Engineer may by notice in writing require the occupier of any premises to provide him with such information, access or facilities as he may deem necessary for the accurate calculation of the charge payable in respect of such premises.

V gelyk is aan die totale hoeveelheid nywerheidsuitvloei- sel wat gedurende die betrokke kringloop van die perseel afgevoer word, in kl;

R gelyk is aan die vervoerkoste van een kl rioolslyk;

T gelyk is aan die koste van die behandeling van een kl rioolslyk;

S gelyk is aan die oppervlakte van die perseel in ha;

"OA" gelyk is aan die suurstof wat deur sodanige uitvloei- sel uit permanganaat geabsorbeer word;

"COD" gelyk is aan die chemiese suurstofvereiste van sodanige uitvloei- sel.

(3) (a) Die suurstof geabsorbeer uit permanganaat en die chemiese suurstofvereiste van nywerheidsuitvloei- sel is die reken- kundige gemiddelde van nie minder nie as vier monsters wat op enige tyd- stip gedurende die betrokke kringloop geneem is, en word bepaal in ooreenstemming met die "Streekstandaarde vir Nywerheidsafvalwater- toetsmetodes" voorgeskryf by Goewer- mentskennisgewing R3208 van 29 Augustus 1969, soos gewysig.

(b) Die okkupeerder van 'n perseel moet, indien hy dit voor die verwydering van enige monster vanaf die perseel versoek het, van een helfte van sodanige monster wat op sodanige perseel geneem is, voorsien word.

(4) Die koste van die behandeling en vervoer van een kl rioolslyk word deur die stadsingenieur bepaal en word gegrond op die werklike koste gedurende die voorafgaande kalenderjaar deur die raad aangegaan in verband met die behandeling van rioolslyk by die raad se rioolwerke by Athlone en van die ver- voer van rioolslyk onderskeidelik.

(5) Die stadsingenieur bepaal die totale hoeveelheid nywer- heidsuitvloei- sel wat gedurende elke kringloop van die perseel afgevoer word en moet vir die doeleindes van sodanige be- paling —

(a) in enige geval waar nywerheidsuitvloei- sel en ander riool- slyk saam gemeet word, met sodanige ander rioolslyk reke- ning hou, in die mate wat hy regverdig ag;

(b) in enige geval waar die hoeveelheid rioolslyk of nywer- heidsuitvloei- sel wat van die perseel afgevoer word, nie reg- streeks gemeet word nie —

(i) sodanige bepaling grond op die hoeveelheid water wat gedurende die betrokke kringloop op die perseel gebruik is, nadat hy, in die mate wat hy regverdig ag, rekening gehou het met water vir huishoudelike doeleindes of besproeiing gebruik, water wat in die atmosfeer verlore gegaan het of water wat in die artikels wat op die perseel vervaardig word, teenwoordig is;

(ii) indien nywerheidsuitvloei- sel by meer as een punt van die perseel afgevoer word, genoemde hoeveelheid water so noukeurig as moontlik aan die afvoerpunte toewys;

(c) in enige geval waar 'n meettoestel afgelees word op datums wat nie in ooreenstemming is met die einde of begin van 'n kringloop nie, die tydperke waarop die aflesings be- trekking het, toewys aan die kringloop waarbinne die grootste gedeelte van sodanige tydperke val, of, indien enige sodanige tydperk gelyk binne twee kringlope val, aan die kringloop wat hy as die geskikste beskou;

(d) in enige geval waar dit blyk dat 'n meettoestel defek is, maar onderworpe aan die bepalings van subregulasie (8), behoorlik rekening hou met sodanige defek;

(e) in enige geval waar die afvoer gedurende 'n kringloop be- gin, die datum bepaal waarop geag word dat sodanige afvoer begin het.

(6) Die stadsingenieur kan gelas dat afgesien word van eni- een of van albei die formules waarna in subregulasie (2) verwys word in enige geval waar hy van mening is dat die metode waarvolgens die sterkte van nywerheidsuitvloei- sel in sodanige formule of formules aangegee, bereken word, nie die sterkte van die betrokke uitvloei- sel noukeurig sal weergee nie.

(7) Die stadsingenieur kan by skriftelike kennisgewing van die okkupeerder van enige perseel vereis om hom te voorsien van enige inligting, toegang of geriewe wat hy nodig ag vir die noukeurig berekening van die bedrag betaalbaar met betrek- king tot sodanige perseel.

(8) The City Engineer shall, after applying the above principles in so far as this is possible, assess the charge due at such amount as he may deem equitable in any case in which —

- (a) both of the formulae referred to in subregulation (2) are dispensed with;
- (b) a notice referred to in subregulation (7) is not complied with;
- (c) any discharge commences during a cycle or a period of measurement;
- (d) any contravention of or failure to comply with any provision of these regulations has taken place and as a result of such contravention or failure the charge due in respect of the premises concerned cannot be calculated accurately.

(9) (a) A charge of R25 shall be paid in any case in which the charge determined as hereinbefore provided does not exceed R25.

(b) The City Engineer may direct that any or all of the aforesaid criteria and procedures be dispensed with in any case in which he is of the opinion that the said minimum charge of R25 is unlikely to be exceeded and the said minimum charge of R25 shall thereupon apply.

(10) The Council shall, in the case of any discharge of industrial effluent which was in existence immediately prior to the fixed date and in respect of which an application to continue such discharge has been made in accordance with regulation 3 (2) (a), grant rebates of 100 per centum of the charge due in terms of this regulation for the first completed cycle to run after the fixed date and 50 per centum for the charge due for the next succeeding cycle and may, in its discretion, grant a rebate of 25 per centum of the charge due for the next succeeding cycle if it is satisfied, upon proof supplied not less than thirty days before the end of such cycle, that steps are being taken to reduce the strength or volume of the effluent concerned and that the implementation of such steps has been delayed by circumstances beyond the control of the person responsible for the discharge.

(11) A local authority which collects any charge due in terms of this regulation on behalf of the Council shall be entitled to a collection fee of 5 per centum of the charge so collected and shall pay the balance to the Council within thirty days after such collection.

*Charges in the Case of Local Authorities*

5. (1) Every local authority discharging industrial effluent into any sewer owned by or under the control of the Council shall, whether or not such industrial effluent is mixed with other sewage, pay to the Council in respect of each cycle, commencing with the third completed cycle to run after the fixed date, during which such discharge takes place such charge as the City Engineer may assess in accordance with the principles laid down in Regulation 4 on the information available to him; the said charge to be paid within thirty days after the Council has rendered an account therefor.

(2) A local authority which makes regulations containing provisions which are to the same effect as are Regulations 3 to 9 inclusive shall, as from the date on which such regulations come into force, pay to the Council in lieu of the charge provided for in subregulation (1) an amount equal to 95 per centum of the charges levied in terms of such regulations.

*Prohibited Discharges into Sewers*

6. (1) No person shall discharge or cause or permit to be discharged any stormwater or other substance which is not sewage directly or indirectly into any sewer.

(2) No person shall discharge or cause or permit to be discharged directly or indirectly into any sewer any sewage which —

- (a) has a temperature exceeding 43° C;
- (b) has a pH value of less than 5,5 or exceeding 12,0;
- (c) contains calcium carbide;

(8) Die stadsingenieur bepaal die vordering, verskuldig op sodanige bedrag, wat hy as regverdig beskou nadat hy bovermelde beginsels toegepas het, in soverre dit moontlik is, in enige geval waar —

- (a) afgesien word van albei die formules waarna in subregulasie (2) verwys word;
- (b) nie voldoen word aan 'n kennisgewing waarna in subregulasie (7) verwys word nie;
- (c) enige afvoer gedurende 'n kringloop of 'n tydperk waartydens aflesings gedoen word, begin;
- (d) enige oortreding van, of versuim om te voldoen aan, enige bepaling van hierdie regulasies plaasgevind het en die bedrag verskuldig ten opsigte van die betrokke perseel as gevolg van sodanige oortreding of versuim nie noukeurig gereken kan word nie.

(9) (a) 'n Vordering van R25 moet betaal word in enige geval waar die vordering, vasgestel soos hierbo bepaal, nie R25 oorskry nie.

(b) Die stadsingenieur kan gelas dat afgesien word van enige van of al voornoemde maatstawwe en prosedures in enige geval waar hy van mening is dat gemelde minimum vordering van R25 waarskynlik nie oorskry sal word nie, en gemelde minimum vordering van R25 is dan van toepassing.

(10) Die raad staan in die geval van enige afvoer van nywerheidsuitvloeiende wat onmiddellik voor die vasgestelde datum bestaan het en ten opsigte waarvan 'n aansoek om sodanige afvoer voort te sit, in ooreenstemming met regulasie 3 (2) (a) gedoen is, kortings van 100 persent toe op die vordering verskuldig ingevolge hierdie regulasie vir die eerste voltooide kringloop wat volg op die vasgestelde datum en 50 persent op die vordering verskuldig vir die daaropvolgende kringloop en kan na goeddunke 'n korting van 25 persent toestaan op die vordering verskuldig vir die daaropvolgende kringloop, indien hy op grond van bewys, minstens dertig dae voor die einde van sodanige kringloop gelewer, oortuig is dat stappe gedoen word om die sterkte of volume van die betrokke uitvloeiende te verminder en dat die uitvoering van sodanige stappe vertraag is deur omstandighede buite die beheer van die persoon wat vir die afvoer verantwoordelik is.

(11) 'n Plaaslike owerheid wat enige bedrag, verskuldig ingevolge hierdie regulasie, ten behoeve van die raad invorder, is geregtig op 'n invorderingsgeld van 5 persent van die vordering aldus ingevorder en moet die saldo binne dertig dae van sodanige invordering aan die raad betaal.

*Vorderings in die geval van plaaslike owerhede*

5. (1) Elke plaaslike owerheid wat nywerheidsuitvloeiende afvoer in enige riool wat die eiendom van die raad is of deur hom beheer word, moet, ongeag of sodanige nywerheidsuitvloeiende met ander rioolslyk gemeng is, aan die raad ten opsigte van elke kringloop, beginnende met die derde voltooide kringloop wat op die vasgestelde datum volg, waartydens sodanige afvoer plaasvind, enige vordering betaal wat die stadsingenieur in ooreenstemming met die beginsels voorgeskryf in regulasie 4, volgens die inligting waaroor hy beskik, bepaal, en gemelde vordering moet binne dertig dae nadat die raad 'n rekening daarvoor gelewer het, betaal word.

(2) 'n Plaaslike owerheid wat regulasies maak wat bepalinge bevat met dieselfde strekking as regulasies 3 tot en met 9, betaal vanaf die datum waarop sodanige regulasies in werking tree aan die raad in die plek van die vordering waarvoor in subregulasie (1) voorsiening gemaak word, 'n bedrag gelyk aan 95 persent van die gelde ingevolge sodanige regulasies gehef.

*Verbode afvoere in riole*

6. (1) Niemand mag enige reënwater of ander stof wat nie rioolslyk is nie, regstreeks of onregstreeks in enige riool afvoer, of laat afvoer of toelaat dat dit daarin afgevoer word nie.

(2) Niemand mag enige rioolslyk regstreeks of onregstreeks in enige riool afvoer of laat afvoer of toelaat dat dit daarin afgevoer word nie wat —

- (a) 'n temperatuur het wat 43° C oorskry;
- (b) 'n pH-waarde van minder as 5,5 het of wat 12,0 oorskry;
- (c) kalsiumkarbid bevat;

(d) contains any substance which gives off or produces or is liable to give off or produce explosive, inflammable, poisonous or offensive gases or vapours;

(e) contains any substance which has an open flash point of less than 93° C;

(f) contains any volatile inflammable solvents or organic solvents immiscible with water;

(g) contains any radio-active waste or isotopes of such nature or in such concentrations as do not meet the requirements laid down by the Atomic Energy Board referred to in section 11 of the Atomic Energy Act, 1967 (Act 90 of 1967);

(h) contains any of the following substances in concentrations in mg per litre exceeding those shown opposite such substances:—

Suspended matter	1 000
Oils, greases and waxes of mineral or animal origin	400
Tars and bitumen products	60
Sugars and starches (as glucose)	1 500
Cyanides and related compounds (as CN)	20
Sulphides (as S)	50
Total sulphates (as SO <sub>4</sub> )	500
Copper (as Cu)	50
Nickel (as Ni)	50
Zinc (as Zn)	50
Cadmium (as Cd)	50
Chromium (as CrO <sub>3</sub> )	50
Total dissolved inorganic solids	2 000

(i) contains any substance which may, in the opinion of the City Engineer, by itself or in combination with any other substances—

(i) cause a nuisance to the public or any section thereof;

(ii) endanger the health of or injure any person, whether employed by the Council or not;

(iii) injuriously affect any sewer or sewage works or any works or land connected with any sewer or with the conveyance, treatment, purification, disposal or re-use of sewage;

(iv) in any way prejudices the disposal or re-use of sewage effluent after treatment or purification or lead to an effluent which does not meet any requirement imposed in terms of the Water Act, 1956 (Act 54 of 1956).

(3) (a) No person shall discharge or cause or permit to be discharged any substance other than industrial effluent directly or indirectly into any separate system of conveyance and discharge required in terms of Regulation 8 (1) (b).

(b) No person shall discharge or cause or permit to be discharged any industrial effluent directly or indirectly into any sewer from any premises on which such a separate system has been provided except through such separate system.

(4) The Council may, for such period and subject to such terms and conditions as it may deem fit (including the payment of any additional costs to be incurred by the Council, the provision of security and the indemnification of the Council), permit any discharge prohibited by the preceding provisions of this regulation.

#### *Discharge into Public Drains and Water Courses*

7. (1) No person shall after the fixed date discharge or cause or permit to be discharged any substance other than stormwater into any public drain, river, stream or other watercourse.

(2) The Council may, for such period and subject to such terms and conditions as it may deem fit, permit any discharge prohibited by subregulation (1); provided that every substance discharged in terms of this subregulation shall comply with the "General Standard" laid down in section 2 of the "Regional Standards for Industrial Effluents" promulgated in Government Notice R553 dated 5 April 1962, as amended.

(d) enige stof bevat wat ontplofbare, ontvlambare, giftige of aanstootlike gasse of dampe afgee of voortbring of wat dit moontlik kan afgee of voortbring;

(e) enige stof bevat wat 'n ope ontbrandingspunt van minder as 93° C het;

(f) enige vlugtige, ontvlambare oplosmiddels of organiese oplosmiddels onmengbaar met water, bevat;

(g) enige radio-aktiewe afvalmateriaal of isotope van 'n aard of in 'n konsentrasie bevat wat nie voldoen nie aan die vereistes voorgeskryf deur die Raad op Atoomkrag waarna in artikel 11 van die Wet op Atoomkrag, 1967 (Wet 90 van 1967) verwys word;

(h) enige van die volgende stowwe in konsentrasies in mg per liter bevat wat dié wat teenoor sodanige stowwe aangetoon word, oorskry:—

Swewede stowwe	1 000
Olie, smeerolie en was van minerale of dierlike oorsprong	400
Teer en bitumenprodukte	60
Suikers en stysels (soos glukose)	1 500
Sianiede en verwante samestellings (soos CN)	20
Sulfides (soos S)	50
Totale sulfate (soos SO <sub>4</sub> )	500
Koper (soos Cu)	50
Nikkel (soos Ni)	50
Sink (soos Zn)	50
Kadmium (soos Cd)	50
Chroom (soos CrO <sub>3</sub> )	50
Totale opgeloste anorganiese vaste stowwe	2 000

(i) enige stof bevat wat volgens die mening van die stadsingenieur op sigself of in samestelling met enige ander stowwe—

(i) 'n oorlas vir die publiek of enige deel daarvan kan veroorsaak;

(ii) die gesondheid van enige persoon, hetsy in diens van die raad al dan nie, in gevaar kan stel of sodanige persoon kan beseer;

(iii) 'n skadelike uitwerking kan hê op enige riool of rioolwerke of op enige werke of grond betrokke by enige riool of by die vervoer, behandeling, suiwering, wegdoen of hergebruik van rioolslyk;

(iv) op enige wyse die wegdoen of hergebruik van rioolwater ná behandeling of suiwering kan benadeel of kan lei tot 'n uitvloeisel wat nie aan enige vereiste, opgelê ingevolge die Waterwet, 1956 (Wet 54 van 1956), voldoen nie.

(3) (a) Niemand mag enige stof behalwe nywerheidsuitvloeisel regstreeks of onregstreeks in enige aparte stelsel van vervoer en afvoer, vereis ingevolge regulasie 8 (1) (b), afvoer, laat afvoer of toelaat dat dit daarin afgevoer word nie.

(b) Niemand mag enige nywerheidsuitvloeisel regstreeks of onregstreeks in enige riool afvoer of laat afvoer of toelaat dat dit daarin afgevoer word vanaf enige perseel waarop so 'n aparte stelsel voorsien is nie, behalwe deur sodanige aparte stelsel.

(4) Die raad kan vir enige tydperk en onderworpe aan enige bepalinge en voorwaardes wat hy gerade ag (met inbegrip van die betaling van enige bykomende koste wat deur die raad aangegaan moet word, voorsiening van sekuriteit en die vrywaring van die raad), enige afvoer wat deur die voorafgaande bepalinge van hierdie regulasie verbied word, toelaat.

#### *Afvoer in openbare riole en waterlope*

7. (1) Niemand mag na die vasgestelde datum enige stof behalwe reënwater in enige openbare riool, rivier, stroom of ander waterloop afvoer of laat afvoer of toelaat dat dit daarin afgevoer word nie.

(2) Die raad kan, vir enige tydperk en onderworpe aan enige bepalinge en voorwaardes wat hy gerade ag, enige afvoer wat by subregulasie (1) verbied word, toelaat; met dien verstande dat elke stof, afgevoer ingevolge hierdie subregulasie, moet voldoen aan die "Algemene Standaard" voorgeskryf in artikel 2 van die "Streekstandaarde vir Nywerheidsafvalwater" afgekondig in Goewermentskennisgewing R553 van 5 April 1962, soos gewysig.

(3) Notwithstanding the provisions of subregulation (1), any discharge prohibited by the provisions thereof which was in existence immediately prior to the fixed date in accordance with any consent or permission granted by the Council may continue as then in existence; provided that every substance discharged in terms of this subregulation shall, commencing with the third completed cycle to run after the fixed date, comply with the "General Standard" referred to in the proviso to subregulation (2); provided further that the Council may, if it is of the opinion that such action is necessary in the public interest or for the protection or efficient functioning of any public drain, river, stream or other watercourse, by notice in writing require the occupier of any premises from which such discharge is taking place to discontinue such discharge by a date specified in such notice or to cause such discharge to be reduced or altered to such extent and in such manner as may be specified in such notice by a date specified therein.

(4) The Council may, if it is of the opinion that the action of rainwater or the use of water on any premises is likely to cause any solid matter, suspended matter, mud, refuse, industrial effluent, chemical or other objectionable liquid or matter to be discharged directly or indirectly into any public drain, river, stream or other watercourse or to pollute any water therein, by notice in writing require the owner of such premises to execute at his own cost such work or measures as it considers necessary to prevent such discharge or pollution.

#### *Additional Powers of the Council*

8. (1) The Council may, in order properly to assess any charge provided for in these regulations or for the purposes of giving effect to or ensuring due and proper compliance with any provision of these regulations or of any term, condition, restriction or requirement imposed in terms thereof, by notice in writing require the owner of any premises, within a period specified in such notice —

(a) to construct or install at his own expense such inspection, sampling and metering chambers of such dimensions, materials and construction and in such positions as it may determine;

(b) to construct or install at his own expense a separate system for the conveyance on and discharge from such premises of industrial effluent;

(c) to provide and maintain at his own expense such gauges or other metering devices as it may deem necessary to —

(i) measure the amount of water used at such premises and obtained from any source other than the Council;

(ii) measure separately the amount of water used for any specified purpose or in any specified portion of such premises;

(d) to provide at his own expense proof to the satisfaction of the City Engineer that any gauge or device referred to in paragraph (c) is functioning correctly and accurately.

(2) Notwithstanding any other provision of these regulations or any consent given in terms thereof, the Council may, if it considers such action necessary for the purposes of —

(i) giving effect to or ensuring due and proper compliance with any provision of these regulations or any term, condition, restriction or requirement imposed in terms thereof;

(ii) protecting any sewer or sewage works or any works or land connected with any sewer or with the conveyance, treatment, purification, disposal or re-use of sewage;

(iii) protecting any person employed in connection with any such sewer, works or land, or

(iv) ensuring the proper conveyance, treatment, purification, disposal or re-use of sewage,

by notice in writing require the occupier of any premises from which industrial effluent is discharged at his own expense to —

(3) Ondanks die bepalings van subregulasie (1) kan enige afvoer wat kragtens die bepalings daarvan verbied word en wat onmiddellik voor die vasgestelde datum bestaan het in ooreenstemming met enige toestemming of vergunning wat deur die raad verleen is, voortbestaan soos op dié tydstip; met dien verstande dat elke stof wat ingevolge hierdie subregulasie afgevoer word, beginnende by die derde voltooië kringloop wat op die vasgestelde datum volg, voldoen aan die "Algemene Standaard" waarna in die voorbehoudsbepaling van subregulasie (2) verwys word; voorts met dien verstande dat die raad, indien hy van mening is dat sodanige optrede nodig is in die openbare belang of vir die beskerming of doeltreffende funksionering van enige openbare riool, rivier, stroom of ander waterloop, by skriftelike kennisgewing van die okkupeerder van enige perseel van waar sodanige afvoer plaasvind, kan vereis om sodanige afvoer te staak teen 'n datum in sodanige kennisgewing aangegee, of om sodanige afvoer te laat verminder of verander in die mate en op die wyse wat in sodanige kennisgewing aangegee word teen 'n datum daarin aangegee.

(4) Die raad kan, indien hy van mening is dat die uitwerking van reënwater of die gebruik van water op enige perseel waarskynlik sal veroorsaak dat enige vaste stof, swewende stof, modder, vuilgoed, nywerheidsuitvloeiëlsel, chemiese of ander aanstootlike vloeiëlsel of stof regstreeks of onregstreeks in enige openbare riool, rivier, stroom of ander waterloop afgevoer word of dat dit enige water daarin sal besoedel, by skriftelike kennisgewing van die eienaar van sodanige perseel vereis om op sy eie koste die werk uit te voer of die maatreëls te trek wat die raad nodig ag om sodanige afvoer of besoedeling te voorkom.

#### *Bykomende bevoegdhede van die raad*

8. (1) Die raad kan, ten einde enige vordering waarvoor in hierdie regulasies voorsiening gemaak word, behoorlik te bepaal of met die doel om uitvoering te gee aan of om behoorlike nakoming te verseker van enige bepaling van hierdie regulasies of van enige bepaling, voorwaarde, beperking of vereiste daarkragtens opgelê, by skriftelike kennisgewing van die eienaar van enige perseel, binne 'n tydperk in sodanige kennisgewing aangegee, vereis —

(a) om op sy eie koste enige inspeksie-, proef- en meterkamers van die afmetings, materiale en konstruksie en in die posisies wat die raad bepaal, te bou of te installeer;

(b) om op sy eie koste 'n aparte stelsel vir die vervoer op en afvoer van sodanige perseel van nywerheidsuitvloeiëlsel te bou of te installeer;

(c) om op sy eie koste enige meettoestelle of ander meterapparaat te verskaf en in stand te hou wat die raad gerade ag om —

(i) die hoeveelheid water wat op sodanige perseel gebruik word en van enige bron uitgesonderd die raad verkry word, te meet;

(ii) die hoeveelheid water wat vir enige aangewese doel of in enige aangewese gedeelte van sodanige perseel gebruik word, afsonderlik te meet;

(d) om op sy eie koste bewys ten genoeë van die stadsingenieur te lewer dat enige meettoestel of apparaat waarna in paragraaf (c) verwys word, korrek en akkuraat funksioneer.

(2) Ondanks enige ander bepaling van hierdie regulasies of enige toestemming daarkragtens verleen, kan die raad, indien hy enige optrede nodig ag vir die doeleindes om —

(i) uitvoering te gee aan of behoorlike nakoming te verseker van enige bepaling van hierdie regulasies of van enige bepaling, voorwaarde, beperking of vereiste daarkragtens opgelê;

(ii) enige riool of rioolwerke of enige werke of grond verbonde aan enige riool of aan die vervoer, behandeling, suiwering, wegdoen of hergebruik van rioolslyk te beskerm;

(iii) iedereen wat in verband met enige sodanige riool, werke of grond in diens is, te beskerm, of

(iv) die behoorlike vervoer, behandeling, reiniging, wegdoening of hergebruik van rioolslyk te verseker,

by skriftelike kennisgewing van die okkupeerder van enige perseel van waar nywerheidsuitvloeiëlsel afgevoer word, vereis dat hy op sy eie koste —

(a) subject such industrial effluent to such treatment as will, in its opinion, ensure that it at all times complies with the requirements of Regulation 6;

(b) discharge such industrial effluent only during specified hours, at a specified rate or at a volume or strength which does not exceed a specified maximum;

(c) discontinue or reduce the discharge of any industrial effluent which, in its opinion, requires special treatment by reason of its volume or strength.

(3) The Council may, in order properly to assess any charge provided for in these regulations or for the purposes of giving effect to or ensuring due and proper compliance with any of the provisions of these regulations or of any term, condition, restriction or requirement imposed in terms thereof, install and maintain on any premises at the expense of the owner of such premises any meter, gauge or sampling or other device for ascertaining the volume, composition or strength of or obtaining samples of any sewage or other substance discharged from such premises or any portion thereof directly or indirectly into any sewer, public drain, river, stream or other watercourse or for ascertaining the volume of water supplied to or consumed on such premises or any portion thereof.

(4) The Council may, in addition to any other powers conferred upon it under these regulations, by notice in writing require the owner of any premises on or in connection with which a contravention of or failure to comply with any provision of these regulations or any term, condition, restriction or requirement imposed in terms thereof has taken place or is taking place, to rectify such contravention or to comply with such provision, term, condition, restriction or requirement, as the case may be, by a date specified in such notice, and the Council may, upon any failure by such owner to comply fully with the requirements of such notice —

(a) itself give effect to the requirements of such notice at the cost of such owner;

(b) at the cost of such owner seal off or block any point of discharge from such premises if such point of discharge is being used in connection with such contravention or failure or if any substance connected therewith is being discharged through such point of discharge, whether or not such point is also being used for lawful purposes or to discharge any substance which may lawfully be discharged;

(c) cancel any consent in connection with which such contravention or failure is taking place or has taken place.

(5) The Council shall, without prejudice to any other power or remedy available to it, be entitled to recover all costs and expenses incurred by it as the direct or indirect result of damage caused to any sewer, sewage works, public drain, river, stream or watercourse or to any works or land connected with any such sewer, sewage works, public drain, river, stream or watercourse by virtue of the discharge thereto of any industrial effluent or of any substance the discharge whereof is prohibited, or as the direct or indirect result of any injury caused to any person by virtue of such discharge, from the person who discharged or caused the discharge of such effluent or substance or, at the discretion of the Council, from the owner or occupier of the premises from which such effluent or substance was discharged.

#### *Maintenance of Traps and the Like*

9. The occupier of premises on which any structure, chamber, tank, trap, meter, gauge, device or other thing has been erected or installed in terms of these regulations or of any other regulation made by the Council in connection with any discharge into any sewer, public drain, river, stream or other watercourse or in connection with any charge provided for in these regulations, other than any such structure, chamber, tank, trap, meter, gauge, device or other thing which was erected or installed and is maintained by the Council, shall ensure that such structure, chamber, tank, trap, meter, gauge, device or other thing is kept free of any blockage and is so maintained and cleaned that it operates efficiently at all times.

(a) sodanige nywerheidsuitvloeiisel aan die behandeling onderwerp wat na die raad se mening sal verseker dat dit te alle tye voldoen aan die vereistes van regulasie 6;

(b) sodanige nywerheidsuitvloeiisel net gedurende vasgestelde tye, teen 'n vasgestelde tempo of teen 'n volume of sterkte wat nie 'n vasgestelde maksimum oorskry nie, afvoer;

(c) die afvoer van enige nywerheidsuitvloeiisel wat na die raad se mening spesiale behandeling vereis as gevolg van die volume of sterkte daarvan, staak of verminder.

(3) Ten einde enige vordering waarvoor in hierdie regulasies voorsiening gemaak word, behoorlik te bepaal of vir die doeleindes om uitvoering te gee aan of om passende en behoorlike nakoming te verseker van enige van die bepalinge van hierdie regulasies of van enige bepaling, voorwaarde, beperking of vereiste daarkragtens voorgeskryf, kan die raad op die koste van die eienaar van sodanige perseel, enige meter, meet- of proefstoel of ander apparaat op enige perseel installeer en in stand hou om die volume, samestelling of sterkte vas te stel van enige rioolslyk of ander stof wat van sodanige perseel of enige gedeelte daarvan regstreeks of onregstreeks afgevoer word in enige riool, openbare riool, rivier, stroom of ander waterloop of om monsters daarvan te verkry of om die volume water wat verskaf is aan of verbruik is op sodanige perseel of enige gedeelte daarvan, vas te stel.

(4) Die raad kan, benewens enige ander bevoegdhede by hierdie regulasies aan hom verleen, by skriftelike kennisgewing vereis dat die eienaar van enige perseel waarop of in verband waarmee 'n oortreding van, of versuim om te voldoen aan, enige bepaling van hierdie regulasies of enige bepaling, voorwaarde, beperking of vereiste, daarkragtens voorgeskryf, plaasgevind het of plaasvind, sodanige oortreding reg stel of voldoen aan sodanige bepaling, voorwaarde, beperking of vereiste, na gelang van die omstandighede, teen 'n datum wat in sodanige kennisgewing aangegee word, en die raad kan, by enige versuim deur sodanige eienaar om ten volle te voldoen aan die vereistes van sodanige kennisgewing —

(a) self op koste van sodanige eienaar aan die vereistes van sodanige kennisgewing uitvoering gee;

(b) op koste van sodanige eienaar enige afvoerpunt van sodanige perseel afdig of afsluit indien sodanige afvoerpunt gebruik word in verband met sodanige oortreding of versuim of indien enige stof wat daarmee in verband staan, afgevoer word deur sodanige afvoerpunt, ongeag of sodanige punt ook gebruik word vir wettige doeleindes of om enige stof wat wettiglik afgevoer kan word, af te voer, al dan nie;

(c) enige toestemming in verband waarmee sodanige oortreding of versuim plaasvind of plaasgevind het, intrek.

(5) Die raad is, behoudens enige ander bevoegdheid of regsmiddel waarvoor hy beskik, daarop geregtig om alle koste en uitgawes deur hom aangegaan as 'n regstreekse of onregstreekse gevolg van skade aan enige riool, rioolwerke, openbare riool, rivier, stroom of waterloop of aan enige werke of grond wat in verband staan met enige sodanige riool, rioolwerke, openbare riool, rivier, stroom of waterloop uit hoofde van die afvoer daarvan van enige nywerheidsuitvloeiisel of van enige stof waarvan die afvoer verbied word of as die regstreekse of onregstreekse gevolg van enige besering aan enigeen uit hoofde van sodanige afvoer veroorsaak, te verhaal op die persoon wat sodanige uitvloeiisel of stof afgevoer het of laat afvoer het of, na goedgeskonde van die raad, op die eienaar of okkupeerder van die perseel van waar sodanige uitvloeiisel of stof afgevoer is.

#### *Onaerhoud van sperders en dergelike*

9. Die okkupeerder van 'n perseel waarop enige struktuur, kamer, tenk, sperder, meter, meetstoel, apparaat of ander voorwerp opgerig of geïnstalleer is ingevolge hierdie regulasies of enige ander regulasie wat deur die raad gemaak is in verband met enige afvoer in enige riool, openbare dreineerleiding, rivier, stroom of ander waterloop of in verband met enige vordering waarvoor in hierdie regulasies voorsiening gemaak word, uitgesonderd enige sodanige struktuur, kamer, tenk, sperder, meter, meetstoel, apparaat of ander voorwerp wat opgerig of geïnstalleer is en onderhou word deur die raad, moet verseker dat sodanige struktuur, kamer, tenk, sperder, meter, meetstoel, apparaat of ander voorwerp vry gehou word van enige versperring en op so 'n wyse onderhou en skoongemaak word dat dit te alle tye doeltreffend werk.

*Uniform Charge for Construction of Certain Sewers*

10. The owner or owners of premises shall, in respect of the construction of a private or combined private sewer from the boundary of such premises to its junction with another sewer providing for such premises the first connection to a public sewer, pay to the Council a charge in accordance with the following table:—

<i>Diameter of sewer constructed</i>	<i>Charge</i>
100 mm	R50
150 mm	R125
225 mm	R200

*Offences and Penalties*

11. Any person who —

(a) contravenes or fails to comply with any provision of these regulations or of any term, condition, restriction, requirement, notice or order imposed or issued in terms thereof;

(b) damages, by-passes, opens, breaks into or otherwise interferes with any meter, gauge or sampling or other device installed by or under the control of the Council;

(c) gives any information required by or in connection with any provision of these regulations or of any term, condition, restriction, notice or order imposed or issued in terms thereof which is false or misleading or who causes or permits any such information which is false or misleading to be given,

shall be guilty of an offence and shall, upon conviction, be liable to a fine not exceeding R100 and, in the case of a continuing offence, to a further fine not exceeding R4 for each day on which such offence is continued.

*Presumption*

12. The occupier of premises shall, for the purposes of these regulations, be deemed to be the person discharging any sewage or other substance discharged from such premises.

*Right of Appeal*

13. (1) Any person aggrieved by any decision or determination made or any notice or order issued by the City Engineer in terms of any provision of these regulations shall —

(a) within seven days after such decision or determination was made or such notice or order was issued, notify the City Engineer in writing that he intends appealing against such decision, determination, notice or order, and

(b) within twenty-one days after such decision or determination was made or such notice or order was issued, lodge with the Town Clerk a written statement stating fully the grounds upon which he appeals against such decision, determination, notice or order and the facts upon which he relies.

(2) The Committee of the Council to which the administration of these regulations has been delegated or, in the absence of such delegation, the Council's Executive Committee shall, after considering the statement referred to in subregulation (1) (b) and the City Engineer's comments thereon, confirm the decision or determination made or notice or order issued by the City Engineer or shall substitute therefor such decision, determination, notice or order as it may deem appropriate and its decision shall be final.

*Repeal of Regulations*

14. Regulations 1206 and 1207 promulgated under Provincial Notice 255 dated 7 July 1921, and the regulations promulgated under Provincial Notice 776 dated 24 October 1969, are hereby repealed.

*Eenvormige vordering vir bou van sekere riole*

10. Die eienaar of eienaars van 'n perseel betaal aan die raad ten opsigte van die bou van 'n private of gemeenskaplike private riool van die grens van sodanige perseel tot die aansluiting met 'n ander riool wat aan sodanige perseel die eerste aansluiting met 'n openbare riool verskaf, 'n vordering in ooreenstemming met die volgende tabel:—

<i>Deursnee van riool gebou</i>	<i>Vordering</i>
100 mm	R50
150 mm	R125
225 mm	R200

*Misdrywe en strafbepaling*

11. Iedereen wat —

(a) enige bepaling van hierdie regulasies of enige bepaling, voorwaarde, beperking, vereiste, kennismaking of lasgewing daarkragtens opgelê of uitgereik, oortree of versuim om daaraan te voldoen;

(b) enige meter, meet- of proef- of ander toestel geïnstalleer deur of onder beheer van die raad beskadig, verontagsaam, opmaak, daarby inbreek of op 'n ander wyse hom daarmee bemoei;

(c) enige inligting verskaf wat vereis word kragtens of in verband met enige bepaling van hierdie regulasies of van enige bepaling, voorwaarde, beperking, kennisgewing of lasgewing daarkragtens opgelê of uitgereik, wat onjuis of misleidend is of wat enige sodanige inligting wat onjuis of misleidend is, laat verskaf of toelaat dat dit verskaf word,

is aan 'n misdryf skuldig en by skuldigbevinding strafbaar met 'n boete van hoogstens R100 en, in geval van 'n voortdurende misdryf, met 'n verdere boete van hoogstens R4 vir elke dag wat sodanige misdryf voortduur.

*Vermoede*

12. Die okkupeerder van 'n perseel word vir die toepassing van hierdie regulasies, geag die persoon te wees wat enige rioolslyk of ander stof afvoer wat van sodanige perseel afgevoer word.

*Reg van appèl*

13. (1) Iedereen wat benadeel is deur enige besluit of beslissing geneem of enige kennisgewing of lasgewing uitgereik deur die stadsingenieur ingevolge enige bepaling van hierdie regulasie moet —

(a) binne sewe dae nadat sodanige besluit of beslissing geneem is of sodanige kennisgewing of lasgewing uitgereik is, die stadsingenieur skriftelik in kennis stel dat hy voornemens is om teen sodanige besluit, beslissing, kennisgewing of lasgewing, te appelleer en

(b) binne een-en-twintig dae na sodanige besluit of beslissing geneem is of sodanige kennisgewing of lasgewing uitgereik is, 'n skriftelike verklaring by die stadsklerk indien waarin hy die gronde waarop hy teen sodanige besluit, beslissing, kennisgewing of lasgewing appelleer en die feite waarop hy staatmaak, volledig uiteensit.

(2) Die komitee van die raad aan wie die administrasie van hierdie regulasies gedelegeer is, of in die afwesigheid van sodanige delegasie, die Uitvoerende Komitee van die raad bevestig, na oorweging van die verklaring waarna in subregulasie (1) (b) verwys word na die stadsingenieur se kommentaar daarop, die besluit of beslissing wat geneem is of kennisgewing of lasgewing wat uitgereik is deur die stadsingenieur of vervang dit deur enige besluit, beslissing, kennisgewing of lasgewing wat hy geskik ag, en sy beslissing is afdoende.

*Herroeping van regulasies*

14. Regulasies 1206 en 1207, afgekondig by Provinsiale Kennisgewing 255 van 7 Julie 1921, en die regulasies afgekondig by Provinsiale Kennisgewing 776 van 24 Oktober 1969, word hierby herroep.



AANSOEKVORM OM TOESTEMMING OM NYWERHEIDSUITVLOEISEL IN RIOLE AF TE VOER.

(Ooreenkomstig Regulasies insake Dreinerings en Riolerings afgekondig by Provinsiale Kennisgewing No. 575 gedateer 11 Junie 1971).

A. NYWERHEID: Naam \_\_\_\_\_ Telefoon \_\_\_\_\_  
 Adres \_\_\_\_\_ Standplaas no. \_\_\_\_\_  
 Dorpsgebied \_\_\_\_\_

B. EIENAAR VAN PERSEEL: \_\_\_\_\_ Telefoon \_\_\_\_\_  
 Adres \_\_\_\_\_

C. SOORTE PRODUKTE - Verwerk of Vervaardig en Beskrywing van Proses, lys produkte indien enige.  
 (i) \_\_\_\_\_  
 (ii) \_\_\_\_\_

D. GETAL WERKNEMERS: Blankes \_\_\_\_\_ Nie-Blankes \_\_\_\_\_

E. BEAMPTTE VERANTWOORDELIK VIR AFVALBESKIKKING: Naam \_\_\_\_\_  
 Betrekking \_\_\_\_\_

F. WATERVERBRUIK: Maks. Daaglik \_\_\_\_\_ Liter. Weeklik \_\_\_\_\_ Liter.  
 (i) Huishoudelike doeleindes as % van totaal \_\_\_\_\_ %  
 (ii) Nywerheidsdoeleindes as % van totaal \_\_\_\_\_ %.

G. UITVLOEISELAFVOER: Maks. Daaglik \_\_\_\_\_ Liter. Weeklik \_\_\_\_\_ Liter.

(i) Bylae van soorte (bv. verkoelingswater, waswater, uitgeputte vloeistof).

SOORT	VLOEIING-LITER/UR	SOORT	VLOEIING-LITER/UR
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(ii) Afvoer as % van totale waterverbruik \_\_\_\_\_ %

(iii) Maksimum vloeitempo \_\_\_\_\_ Liter/uur.

(iv) Afvoertydperk \_\_\_\_\_ uur.

(v) Afvoertyd \_\_\_\_\_ vm. \_\_\_\_\_ nm.

(vi) Afvoerdag Maandag - Vrydag \_\_\_\_\_ Sat. \_\_\_\_\_ Son. \_\_\_\_\_

H. VOORBEHANDELING VAN UITVLOEISELS:

Soort \_\_\_\_\_ Kapasiteit \_\_\_\_\_ liter/uur.

Beskrywing van voorbehandelingsinstallasie \_\_\_\_\_

TABLE 2. (Appendix 2A)



APPLICATION FORM FOR PERMISSION TO DISCHARGE INDUSTRIAL EFFLUENT INTO SEWERS.

(In terms of Drainage and Sewerage Regulations promulgated under Provincial Notice No. 575 dated 11th June, 1971).

A. INDUSTRY: Name \_\_\_\_\_ Telephone \_\_\_\_\_  
 Address \_\_\_\_\_ Stand No. \_\_\_\_\_  
 Township \_\_\_\_\_

B. OWNER OF PREMISES: \_\_\_\_\_ Telephone \_\_\_\_\_  
 Address \_\_\_\_\_

C. TYPES OF PRODUCTS - Processed or Manufactured and Description of Process, list products if any.

(i) \_\_\_\_\_  
 (ii) \_\_\_\_\_

D. NUMBER OF EMPLOYEES: White \_\_\_\_\_ Non-White \_\_\_\_\_

E. OFFICIAL RESPONSIBLE FOR WASTE DISPOSAL: Name \_\_\_\_\_  
 Position \_\_\_\_\_

F. WATER CONSUMPTION: Max Daily \_\_\_\_\_ Litres. Weekly \_\_\_\_\_ Litres.

(i) Domestic purposes as % of total \_\_\_\_\_ %

(ii) Industrial purposes as % of total \_\_\_\_\_ %

G. EFFLUENT DISCHARGE: Max. Daily \_\_\_\_\_ Litres. Weekly \_\_\_\_\_ Litres.

(i) Schedule of Types (e.g. Cooling water, wash water, Spent liquors)

TYPE	FLOW-LITRES/HR.	TYPE	FLOW-LITRES/HR.
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(ii) Discharge as % of total water consumption \_\_\_\_\_ %

(iii) Maximum Flow Rate \_\_\_\_\_ Litres/hr.

(iv) Period of discharge \_\_\_\_\_ hours.

(v) Time of discharge \_\_\_\_\_ a.m. \_\_\_\_\_ p.m.

(vi) Days of discharge, Mon-Fri. \_\_\_\_\_ Sat. \_\_\_\_\_ Sun. \_\_\_\_\_

H. PRETREATMENT OF EFFLUENTS:

Type \_\_\_\_\_ Capacity \_\_\_\_\_ litres/hr.

Description of pretreatment plant \_\_\_\_\_

I. ANALYSIS OF EFFLUENT: Give maximum concentrations occurring or likely to occur. (answers where applicable to be in parts per million or milligrams per litre).

Temperature _____	Cyanides and related
pH Value _____	compounds (as CN) _____
Calcium carbide _____	Chlorides (as Cl) _____
Radio-active waste or Isotope _____	Sulphides (as S) _____
Organic solvents _____	Total sulphates (as SO <sub>4</sub> ) _____
Total dissolved in-organic solids _____	Copper (as Cu) _____
Total suspended matter _____	Nickel (as Ni) _____
Oils, greases or wax _____	Zinc (as Zn) _____
Tar and bitumen products _____	Cadmium (as Cd) _____
Sugars and starch (as glucose) _____	Chromium (as CrO <sub>3</sub> ) _____

Give an analysis of a 24 hour composite sample of the effluent for:

Oxygen absorbed from N/80 permanganate \_\_\_\_\_

Chemical Oxygen Demand \_\_\_\_\_

Any further information, Chemical or Physical, regarding the effluent - give concentrations where applicable.

---

**NOTE:** Notice, giving details of any intended changes in process or production which will result in variation in quality and quantity of effluent, shall be forwarded to the City Engineer before the operation thereof or discharge of effluent is commenced.

APPLICANT:

I (NAME) \_\_\_\_\_

the undersigned, duly authorised to act on behalf of \_\_\_\_\_ and hereinafter referred to as the applicant, hereby apply in terms of the Municipal Drainage and Sewerage Regulations of the City Council of Cape Town for permission to discharge industrial effluent into the Council's sewer on the basis of the facts stated herein.

SIGNED \_\_\_\_\_

I. ONTLEDING VAN UITVLOEISEL: Verstrek maksimum konsentrasies wat voorkom of waarskynlik sal voorkom. (Antwoorde waar van toepassing moet in dele per miljoen of milligram per liter wees).

Temperatuur _____	Sianiede en verwante samestellings (soos CN) _____
pH-waarde _____	Chloriede (soos Cl) _____
Kalsiumkarbied _____	Sulfides (soos S) _____
Radio-aktiewe afvalmateriaal of isotope _____	Totale sulfate (soos SO <sub>4</sub> ) _____
Organiese oplosmiddels _____	Koper (soos Cu) _____
Totale opgeloste anorganiese vaste stowwe _____	Nikkel (soos Ni) _____
Swewende stowwe _____	Sink (soos Zn) _____
Olies, smeerolie of was _____	Kadmium (soos Cd) _____
Teer- en bitumenprodukte _____	Chroom (soos CrO <sub>3</sub> ) _____
Suikers en stysel (soos glukose) _____	

Gee 'n ontleding van 'n saamgestelde monster oor 24 uur van die uitvloei sel vir:

Suurstof geabsorbeer van N/80-permanganaat \_\_\_\_\_

Chemiese suurstofvereiste \_\_\_\_\_

Enige nadere inligting, Chemies of Fisies, rakende die uitvloei sel - gee konsentrasies waar van toepassing.

LET WEL: Die Stadsingenieur moet in kennis gestel word, met vermelding van besonderhede, van enige beplande veranderings in proses of produksie wat sal lei tot verandering in gehalte en hoeveelheid van uitvloei sel, voordat dit in werking tree of die afvoer van uitvloei sel 'n aanvang neem.

AANSOEKER:

Ek (NAAM) \_\_\_\_\_

die ondergetekende, behoorlik gemagtig om op te tree namens en na wie hierna verwys word as die aansoeker, doen hierby aansoek ooreenkomstig die Regulasies insake Dreinerings en Riolerings van die Stadsraad van Kaapstad om toestemming om nywerheidsuitvloei sel in die Raad se riool af te voer in ooreenstemming met die feite hierin verstrek.

GETEKEN \_\_\_\_\_

# CITY OF CAPE TOWN STAD KAAPSTAD

DR. S. S. MORRIS  
CITY ENGINEER—STADSINGENIEUR

TELEPHONE: TELEFOON: 45-5461

EXTENSION:

BYLYN:



CITY ENGINEER'S DEPARTMENT  
DEPARTEMENT VAN DIE STADSINGENIEUR

CITY PARK —STADSPARK  
181 LONGMARKET STREET — LANGMARKSTRAAT 181  
CAPE TOWN — KAAPSTAD

P.O. BOX 1694 — POSBUS 1694

REF. NO.	VERWYSNO.
R/S/6/2/2	

Messrs

Dear Sirs,

Drainage and Sewerage Regulations: Application  
to Discharge/to continue to discharge Industrial  
Effluent into sewers: Serial No.  
Premises:

---

The effluent as described on the above application form is  
unacceptable for the following reasons:-

As these parameters are in excess of the limits laid down in  
Regulation No. 6, I hereby call upon you, in terms of Regulation  
No. 8(2) to carry out the following requirements within six(6) calendar  
months of the date hereof:-

2/...

Furthermore, I require you to inform me within one(1) calendar month of the date of this letter as to what steps you propose to take in this regard.

I must point out that failure on your part to obtain the Council's written consent in terms of Regulation (3) will not only result in action by the Council in terms of the Regulations but may lead to action against you by the Department of Water Affairs, unless you have complied with Section 12 of the Water Act of 1956 (as amended). A copy of the Council's Drainage and Sewerage Regulations, as well as relevant extracts from the Water Act, were sent to you together with the application forms.

Yours faithfully,

CITY ENGINEER

# CITY OF CAPE TOWN STAD KAAPSTAD

DR. S. S. MORRIS  
CITY ENGINEER—STADSINGENIEUR

TELEPHONE: TELEFOON: 45-5461

EXTENSION:

BYLYN:



CITY ENGINEER'S DEPARTMENT  
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CAPE TOWN — KAAPSTAD

P.O. BOX 1694 — POSBUS 1694

REF. NO.	VERWYSNO.
R/S/6/2/2	

Messrs.

Dear Sirs,

Drainage and Sewerage Regulations:  
Application to Discharge Industrial Effluents  
into sewers: Serial No.  
Premises:

---

From the information disclosed in your application form, Serial No. there would appear to be no discharge of industrial effluent from your premises.

On this account your premises have been classified as using water for "domestic purposes only" and are not, therefore, liable for Industrial Effluent Charges as laid down in Regulation No. 4.

I have to draw your attention to Regulation No. 3 and to emphasise that this letter does not give you any authority to vary the nature of the effluent discharged.

— A photocopy of your application form is returned herewith for your records.

Yours faithfully,

CITY ENGINEER.

TABLE 2. (Appendix 2C)



and the following special conditions:

Kindly acknowledge receipt of this consent within fourteen(14) days of the date hereof and furnish me within thirty (30) days of the date hereof your written acceptance of the conditions laid down.

Your acceptance of the foregoing written consent does not exempt you from your obligations under the Water Act of 1956 (as amended). This document may be used in support of any application which you are required to submit to the Department of Water Affairs in terms of Section 12 of the Act.

Yours faithfully,

CITY ENGINEER

that the maximum uptake of 500mg/litre specified in the general standards will have to be enforced on all effluent contributors as is the case in East London. At the same time limits for chlorides should be specified at low levels if agricultural use is to be made of effluents; the sodium level must also be specified.

South Africa has comparatively few rivers where the cycle of extraction for human activities and subsequent return is practised to any extent. One river with a perennial flow where this cycle is repeated is of course the Vaal River.

Table 3<sup>(4)</sup> shows changes in important parameters in the Vaal River between Villiers and Kimberley resulting from both geology and human activities.

TABLE 3

	Vaal River			
	At Villiers upstream from Vaal Dam.	At the Barrage	At Bloemhof	At Kimberley
Dissolved Solids	150	465	270	670
Magnesium as CaCO <sub>3</sub>	42	90	59	157
Calcium as CaCO <sub>3</sub>	52	140	89	159
Sodium as Na	15	37	73	80
Chloride as Cl	18	57	31	90
Sulphate as SO <sub>4</sub>	10	120	43	168
Alkalinity as CaCO <sub>3</sub>	106	94	114	102

The increase in dissolved solids is significant and could be very serious indeed if the river were not diluted by tributaries of lower salinity.

In the Western Cape, the "pure" waters from the mountain catchments cannot be returned to the rivers. An exception is the

Berg River of which the dammed Wemmers River is a tributary. Both Paarl and Wellington receive some water from the Wemmershoek Dam and return effluents to the Berg River; compensation water is also discharged from the dam.

The Cape Town water undertaking is thus in conflict with the Water Act in this respect and the use of sewage effluent is of great importance when considered against increases in water consumption, the limitations of the natural water resources, and the consequent need to conserve them.

The long term position is serious and the thoughts of water resource planners have turned to reclamation of sewage effluents, and desalination of sea water or sources of comparatively low salinity, such as the Diep River north of Milnerton.

As long as water is made available without restriction, and at a low cost, there is an inherent resistance to use of sewage effluents. Indeed, unless suitable "markets" for sewage effluent can readily be found there would seem to be little need, apart from health and ecological considerations, to treat sewage so as to attain the high standards required particularly as long as the effluent is discharged to the sea without untoward consequences.

While attainment of the standards for bacterial and organic parameters can be reached without difficulty, the treatment processes do not have any material effect in reducing the salinity - the concentration of total dissolved inorganic solids which will be referred to as "TDS" in this paper.

The position must therefore be examined on the basis of the necessity to reduce the mineral load before sewage effluents can successfully be re-used by the community.

In the overall economy a decision has to be made as to whether there should be a reduction of mineral load at source or

whether this load should be reduced after normal treatment processes by one or more of the several desalination processes which are currently available.

The present state of knowledge in regard to desalination is quite clearly confined to small volumes and it is apparent that technology must advance considerably before large scale desalination becomes a reality in South Africa.

An alternative to be considered is the separation of highly saline waters, as was the basis of the proposals for the Los Angeles Metropolitan Area and for the Los Angeles County<sup>(6)</sup>.

Chapter 3:            SOURCES AND QUALITY OF PRESENTLY  
EXPLOITED WATER RESOURCES OF THE  
CAPE TOWN MUNICIPAL WATER UNDER-  
TAKING.

Apart from comparatively small water storage schemes on Table Mountain, the main sources of supply of the Cape Town Municipal water undertaking are the municipally owned Steenbras and Wemmershoek Dams.

The natural waters from these dams are soft and corrosive and their mineral salt content is, in common with all waters originating in the Table Mountain geological series, very low.

The supplies are at present treated and stabilised to a pH of about 9 and the mineral salt content is raised to between 60 and 80mg/litre by the treatment processes in order to minimise corrosion.

As the State has now assumed responsibility for water storage schemes, Cape Town has received further water supplies from the State storage dam at Voëlvlei.

This dam receives its main supplies from the Klein Berg River and the Twenty Four Rivers Schemes and its natural bed for about half of its extent comprises a dolomite base.

The resulting water has a higher pH than the upland waters of Wemmershoek, Steenbras and Table Mountain and a higher content of dissolved inorganic solids: the waters after treatment have a TDS of between 190 and 250mg/litre.

The waters from all sources are combined, the degree of mixing being controlled by specific needs in the distribution system.

However, the final effluent from Cape Town's sewage treatment works has a TDS of between 840 and 930mg/litre<sup>(7)</sup>.

This range of TDS is surprisingly high when considered in relation to the exceptionally low salinities of the Wemmershoek and Steenbras treated waters.

The increased use of Voëlvlei water will undoubtedly lead to increased salinity in the final effluent.

Chapter 4:            BRIEF DESCRIPTION OF THE CAPE  
                          TOWN SEWERAGE SYSTEM.

The Cape Town Municipal Area as presently constituted comprises a number of former municipalities which amalgamated in 1913, together with Wynberg (1929) and several local areas of the Divisional Council of the Cape (1971).

The greater portion of the area is sewered and waterborne sewerage is being extended as rapidly as the financial situation permits to developing areas; waterborne sewerage is always provided in Municipal Housing Schemes. Since July 1971 all Township Developers cannot develop land unless waterborne sewerage is provided.

The total length of sewers, ranging in size from 1500mm to 150mm now totals 1480 kilometres.

The earliest sewerage schemes were those serving the area from Sea Point to Woodstock, and constructed during the years 1897 - 1902; these comprised 200 kilometres of sewers. Disposal was by means of sea outfalls and this method is still in use, the several outfalls having been combined into one at Green Point.

The effluent from this outfall (together with that at Camps Bay, constructed about 1927) is almost entirely of domestic origin with a salinity of approximately 300mg/litre (TDS). It has been argued in recent times that this effluent lends itself to reclamation and re-use; provision of on-site treatment is difficult because of space considerations and diversion for treatment inland too costly to justify the capital outlay, probably in excess of R10 million for an ultimate total of some 36Ml/day.

It should be noted that the sewers in the areas served by sea outfalls are in excellent condition and comprise either salt glazed vitrified clay pipes or Staffordshire Blue Brick linings to

concrete tubes.

As the sewered areas are mainly on mountain slopes, the matter of saline ground water infiltration has never arisen; there is no evidence that ground water infiltration occurs to any extent in these areas.

The next major schemes were those constructed by Wynberg between 1902 and 1905 and comprising 55 kilometres of sewers, with land treatment east of Zeekoe Vlei - now modified to oxidation ponds, and Kalk Bay (which included Muizenberg and St. James), between 1907 and 1910. This latter scheme included 30 kilometres of sewers and the first use of oxidation pond treatment, which, incidentally functioned perfectly for 50 years.

After unification in 1913, waterborne sewerage was extended to serve Salt River, Maitland and the suburbs of Observatory, Mowbray, Rosebank, Rondebosch, Newlands, Claremont and Kenilworth. In all, 240 kilometres of sewers were laid and six automatic sub-pumping stations constructed. The main pumping station at Raapenberg was constructed in 1919 and is still in use today; this installation delivered sewage to treatment works near the present site at Athlone; the first use of brushwood trickling filters is recorded.

By the mid-1930's the length of sewers had reached 570 kilometres and the value of the schemes was R4 600 000.

The tremendous expansion of the metropolitan area since World War II necessitated the extension of waterborne sewerage to the Cape Flats and the Council has by agreement accepted, for treatment, sewage from Goodwood, Parow, Pinelands and the Cape Divisional Council Local Areas of Constantia and Grassy Park. This growth led to increased treatment capacity at Athlone and the construction of an oxidation pond treatment complex to the south

of Zeekoe Vlei.

At the end of 1971, with a total length of sewers in the Cape Town Municipal Area of 1480 kilometres the value of installations, including 50 pumping stations, sea outfalls and treatment works, was about R40 000 000.

The extension of sewerage to the Cape Flats - an area of perennially high but variable water table - involved construction under exceptionally bad sub-surface conditions and workmanship must accordingly be of a very high order.

As can be expected, there are defects in pipes - faulty joints, due to post constructional settlement or poor workmanship, and frequently house connections are defective.

This situation has given rise to the impression that the sewers leak to a marked extent and that it is this infiltration of saline ground water - high in chlorides - that has produced the high salinity of the final effluent from the Athlone treatment works which receives sewage from many areas of high water table.

If this position was true, there would be no respite for the pumping stations, which show no distress other than from contributor loadings, except during long spells of rain when rainwater reaches the sewers through defective house sewerage and connections.

Figure 4 (which is a still photograph of a closed circuit television viewing of a leak in a 225mm sewer in Paarden Eiland) illustrates this statement. The leakage here is sea water, with a TDS of 35 000mg/litre. Salinity investigations show several marked waves of highly saline industrial effluent by day in the sewerage system of this area, reaching in some instances as much as 25 000mg/litre and dropping by night to about 500mg/litre. As most of the Paarden Eiland sewers are below mean sea level the night time

salinities should approximate to the figure for sea water. Figures 16 and 26 (Station 28) illustrate fluctuations in a sewer in this area. The two pumping stations serving this area do not exhibit any distress by day or night.

There is no doubt that there are leaks; these are being televised as rapidly as circumstances permit. The shallower house connections and sewers also contribute infiltration, but mainly of a seasonal nature. In-situ repair schemes involving injection of sealing grouts are being investigated; of the available methods, the "Infiljet" process developed in the United States of America appears most promising.

However, as subsequent chapters will show, the high salinities in the sewers draining to the Athlone Treatment Works are mainly due to industrial effluents.

Chapter 5:            MINERAL CONTENT OF CAPE TOWN SEWAGE.

The normal domestic use of water in residential areas in Cape Town increases the mineral salts content by about 220mg/litre and results in a TDS of approximately 300mg/litre when Wemmershoek, Steenbras or Table Mountain water is supplied. With Voëlvlei water, the TDS could be expected to reach 400 - 450mg/litre as the TDS concentration in the treated water leaving the dam averages 200mg/litre. However, water from various sources is mixed.

As the upper limit for Class "A" drinking waters is set at 500mg/litre the purification of a purely "domestic" sewage would impose no serious problems.

However, as the TDS of the final effluent from the Athlone Sewage Treatment plant is of the order of 900mg/litre<sup>(7)</sup> a considerable reduction of this load must be effected before the effluent can be recycled into the potable supplies in view of the build up of salts if re-cycling is practised more than once.

Very little information is available regarding the effects on agriculture of the prolonged use of sewage effluents with a high mineral salt content. This matter is a subject for special research.

However, the following points are pertinent:

1. The Cape Flats has been used for agricultural purposes for many years; as the sub-surface waters are highly mineralised, and are used by farmers, the continued fertility of the sandy soils is no doubt due to the leaching out of salts by the winter rains.

Certain areas of the Flats (Phillipi) are remarkably fertile and interest has been shown in obtaining sewage effluents for irrigation. It is more than likely that the high TDS of the Athlone effluent would have harmful effects.

2. Where effluents have been used for irrigation of sporting amenities no build up of salts has been experienced in sandy areas probably because of the leaching effect of the rains. In addition, indigenous grasses, used for golf courses and sports fields, have a high salt tolerance.
3. The effect of continued irrigation of cohesive soils by effluent from Athlone has never been practised and experiments are being carried out to evaluate long-term effects on fruit trees; several years must necessarily elapse before any valid conclusions can be made.
4. Crops such as tomatoes are known to have a very low tolerance for chlorides. In Holland, which faces the end result of pollution of the River Rhine, a limit of 200mg/litre for chlorides has been set for agricultural use. In the United States acceptable limits of under 175mg/litre are quoted<sup>(8)</sup>.

The chloride content of the Athlone effluent is well in excess of this figure - 280 mg/litre - and represents about one third of the total mineral load<sup>(7)</sup>.

Now the chloride content of the water supply of Cape Town from the Steenbras, Wemmershoek and Table Mountain Sources varies between 10 and 30 mg/litre<sup>(7)</sup>; Voëlvlei water has about three times this range.

Domestic sewage in Cape Town from areas supplied with water from Steenbras, Wemmershoek or Table Mountain has a chloride content ranging from 70 to 90 mg/litre<sup>(7)(9)</sup>; the use of Voëlvlei supplies will increase these amounts.

With an effluent discharge of some 98 Ml a day, the total mineral load in the Athlone Effluent is nearly 80 metric tonnes daily; as will be seen in Chapter 12 and 13, domestic sewage would account for some 30 tonnes daily. The approximate masses of chlorides discharged would thus be respectively 28 and 8 tonnes.

The need to investigate sources of salinity is clearly demonstrated.

Chapter 6:            NEED FOR INVESTIGATION AND SURVEY.

In 1969 the National Institute for Water Research requested the City Council to collaborate research into salinity of sewage in order to attempt to classify various contribution areas in relation to ease of water reclamation.

Staff and equipment were not readily available, so the National Institute for Water Research undertook a fairly rapid survey, covering a period of about 12 months.

The equipment and findings were presented to the "Steering Committee for Use and Re-use of Water in the Cape Province"<sup>(9)</sup>

Regrettably the findings did not convey a true picture and were based on inferences from hourly sampling over a period of one to three days without any volumetric correlation whatsoever.

The main conclusion reached, (based on a survey of small sewers in a selected area) was that the high mineral loads were primarily due to ground water infiltration; the report indicated a high correlation between mineral loads in sewers and the ground water in the vicinity.

If it were entirely true, then the major portion of the sewerage scheme serving the Cape Flats residential areas would be subject to high night flows of highly saline water.

As this is not the case, the author, responsible for the sewerage system, of the City was placed in the invidious position of having to challenge the reports presented by the National Institute of Water Research.

He was then requested to collaborate with the National Institute of Water Research in carrying out further investigations on a properly co-ordinated basis.<sup>(10)</sup>

This work has now been in progress for over a year and the findings (in regard to the catchment of the Athlone Works) are reported in Chapter 12.

Investigations have been extended to the catchments for the Wynberg and Cape Flats Treatment Works and the results should be available during 1973.

Chapter 7:            METHODS EMPLOYED AND EQUIPMENT USED.

In view of the general shortage of qualified staff, the present field investigations have been conceived around the use of automatic equipment, placed, checked and serviced daily, by one trainee technician.

This man, working to a co-ordinated plan, arranges with the normal sewer maintenance staff to transport and place the sheds housing the equipment.

The sheds, which provide reasonable security against vandalism, comprise portable corrugated iron structures approximately 1,5 x 3 x 2,5 metres high; the floor is omitted.

When circumstances permit, up to five sampling points are established at one time to enable any abnormality in salinity to be traced to a particular tributary.

At each sampling point, the shed is set up over a sewer manhole which remains open, but under cover, for the duration of the sampling period.

The Kent-Lea 24 bottle automatic sampler was selected as this equipment has given good service elsewhere; it is, however, inclined to be temperamental in use. The sampler includes a battery driven electric peristaltic pump which evacuates the suction line before sampling; a spring driven clock moves the discharge nozzle at hourly intervals to a new bottle. A sampler in use at Station No. 5 is illustrated in Figure 1.

The determination of sewer volumes posed a problem particularly in sewers in excess of 250mm diameter. On smaller sewers, the Council for Scientific and Industrial Research measuring flume provides an accurate means of measuring flow; <sup>(11)</sup> this flume is

SPECIFICATION FOR EFFLUENTS

(Maximum permissible concentrations)

All units in mg/l except otherwise stated

	Water Act No. 54, 1956	Local Authority Regulations						
	General Standards	Johannesburg	Pretoria	Durban	Bellville	Cape Town, Goodwood Parow, Milnerton.	East London	Port Elizabeth
pH	5,5 - 9,5	> 6,0	6 - 10	> 6,0	4 - 10	5,5 - 12,0	6,0 - 10	6,0 - 12,0
Faecal coli	Nil	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Dissolved O <sub>2</sub>	> 75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Temperature	35°C	N.S.	N.S.	< 100°F	< 43°C	< 43°C	< 44°C	< 44°C
Chemical oxygen demand (COD)	75	N.S.	5 000	N.S.	N.S.	N.S.	N.S.	N.S.
4 hrs OA	10	1 400	200	N.S.	N.S.	N.S.	N.S.	1 000
TDS	Not increasing to more than 500 above intake	N.S.	2 000	N.S.	N.S.	2 000	Not increasing to more than 500 above water supplied	N.S.
Electrical conductivity	N.S.	5 000 micromhos	N.S.	N.S.	N.S.	N.S.	N.S.	5 000
Suspended solids	max. 25	N.S.	600	2 000	500	1 000	1 500	1 000
Sodium (as Na)	Not more than 50 above intake	N.S.	75	N.S.	N.S.	N.S.	100	
Soap, oil and grease	max. 2,5	N.S.	400	50	400	400	400	400
Substances not in solution (incl. fat, oil, grease, waxes, etc.)	N.S.	2 000	N.S.	N.S.				
Substances soluble in petroleum ether	N.S.	500	N.S.	N.S.	Nil	Nil	Nil	400
Chlorides	N.S.	N.S.	N.S.	1 000	N.S.	N.S.	1 000	1 000
Free Cl	max. 0.1	100	N.S.	N.S.	N.S.	N.S.	N.S.	
Free and saline NH <sub>3</sub>	10	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
Phosphates (as P)	N.S.	N.S.	Nil	N.S.	N.S.	N.S.		N.S.
Silver (as Ag)	N.S.	N.S.	Nil	N.S.	N.S.	N.S.		
Iron (as Fe)	N.S.	} total concentration of all metals 50; individual metal 20	N.S.	N.S.	N.S.	N.S.	25	20
Chromium (as Cr)	0.5		20	50	50	50	25	20
Copper (as Cu)	1.0		20	50	50	50	25	20
Nickel (as Ni)	N.S.		20	50	50	50	25	20
Zinc (as Zn)	5.0		20	50	50	50	25	20
Cadmium (as Cd)	N.S.		20	50	50	50	25	20
Arsenic (as As)	0.5	} total of all metals 20; individual metal 5	N.S.	N.S.				5
Boron (as B)	1.0		N.S.	N.S.				5
Lead (as Pb)	1.0		N.S.	N.S.	N.S.	N.S.	N.S.	5
Selenium (as Se)	N.S.		N.S.	N.S.				5
Mercury (as Hg)	N.S.		N.S.	N.S.				5
Sulphides (as S)	1.0	50	20	50	50	50	50	50
Fluorides (as F)	1.0	5	N.S.	N.S.	N.S.	N.S.	N.S.	5
Phenols	0.1	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
Formaldehyde	N.S.	50	N.S.	N.S.	N.S.	N.S.	N.S.	20
Cyanides (as CN)	0.5	20	10	20	20	20	20	20
Total sugars and starch	N.S.	1 500	N.S.	1 500	1 000	1 500	1 000	1 000
Tar and tar oils not soluble in water	N.S.	N.S.	60	60	60	60	60	50
Calcium carbide	N.S.	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total sulphates	N.S.	1 800	300	200*	250**	500	500	1 500

N.S. = Not specified

\* sulphate in solution

\*\* Insoluble sulphates

TABLE 1.



FIGURE 1: KENT-LEA 24 BOTTLE AUTOMATIC SAMPLER IN USE AT STATION 5.



FIGURE 2: NITROGEN CYLINDER AND PRESSURE GAUGE RECORDING DEPTH OF FLOW AT STATION 5.

not, however, available in sizes of more than 200mm. As the investigations were to be spread mainly over sewers in excess of 250mm it was necessary to devise some way of assessing the flow.

It was decided to adopt the bubble pressure recording gauges normally used with the Council for Scientific and Industrial Research flume to determine depths of flow. (11)

These gauges measure the pressure which is necessary to displace a bubble of air (or nitrogen) from a tube placed below the water level; they are normally placed in a small stilling chamber on the side of the flume.

Experiments showed that a fair degree of accuracy could be achieved by bubbling gas through a rigid small bore copper pipe. Furthermore, as for practical reasons it is not possible to place the pipe on the invert, a correction factor, representing the distance of the pipe from the sewer invert is used to measure the true depth. Thus, in positioning the copper pipe, the distance between its end and the invert of the pipe must be measured.

The mechanism of the gauge was modified so as to halve the recorded depth - this enables the gauge to be used on sewers of up to 1200mm diameter. Unfortunately investigations on some large sewers (Stations 18, 19 and 20 for example) were undertaken before this modification was made.

The gauge calibrations were checked under static conditions in the Hydraulics Laboratory of the University of Cape Town.

The technician is responsible for the recovery of the samples and the charts from the recorders, and for reducing the readings at each hour to the true depth.

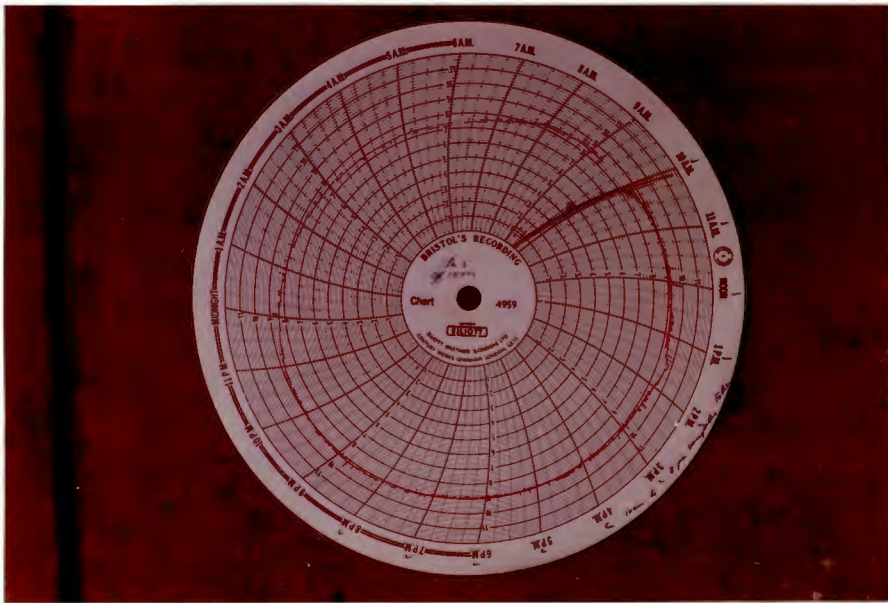


FIGURE 3: DEPTH RECORDER CHART FOR STATION 5, CALIBRATED IN HALF INCHES. DEPTH AT 11.00 A.M. IS  $9,0 \times 2 +$  DISTANCE OF BUBBLE PIPE FROM INVERT

$$= 18 + 9 = 27 \text{ INCHES}$$

The volumes are then determined by using standard tables and proportional depths; tables by Crimp and Bruges<sup>(12)</sup> are currently in use.

The volumetric determinations are reasonably accurate enough for the purposes of the investigation and the sum of flows as recorded by several gauges on branch sewers bears a very close correlation to the gauge measuring the total flow. Actual velocities are checked by the salt-dilution method. However, calculated flows on the outfall sewers near to the Langa Main Pumping Station are considered to be too high, probably due to reflection of top water levels in the station itself.

Because of the high cost of bottled compressed air, bottled nitrogen is used; this is considerably cheaper than air.

Figure 2 shows a gauge in use with its attendant gas bottles and pressure reducer; while Figure 3 shows a completed chart for Station No. 5 a 36" (910mm) diameter pipe; the depth recorded at 11.00a.m. is for example  $2 \times 9 + \text{correction}$  factor  $9 = 27$  inches.

The sample bottles are delivered to the Council's Chemical Laboratory for TDS determinations.

The method used is to measure the conductivity with standard testing equipment employing a cell with electrodes 10mm apart.

The conductivity of a liquid is proportional to the ionic concentrations and a calibration factor can be determined for each range of TDS concentration desired; in this way fairly rapid but approximate results can be obtained.

However, the procedure at present followed is to determine the actual total dissolved inorganic solids concentration in four to six of the 24 samples in accordance with the methods laid down in "Regional Standards for Industrial Effluents - Methods

of Testing"<sup>(13)</sup> and a conversion factor determined for the particular set of samples.

In view of this, there is a delay in obtaining the information. However, the reliability of the determination is more important at this stage and when sufficient experience has been obtained the direct conductivity will be used for tracing of specific sources of high saline effluents.

The TDS concentrations of the data used in presenting this report may therefore be considered of high reliability.

This probably accounts for the generally lower readings that were obtained using a single conversion factor for the results reported in reference (9).

Chapter 8:            INTERNAL INSPECTION OF SEWERS.

With the "separate" system for sewers (i.e. exclusion of stormwater) the sizes of even the largest sewers in Cape Town (1500mm) do not permit of internal inspection by maintenance staff.

A time-honoured method of inspection is the use of sunlight reflected into the sewer by two mirrors. An experienced operator, holding the first mirror above ground level can evaluate, but not easily pin point, defects in the pipes by observing in the second mirror (held by a second man in the invert of a particular manhole) the reflection of the now well illuminated pipe bore.

In 1966 the South African Council for Scientific and Industrial Research published in its Bulletin of Technical Information for Industry<sup>(14)</sup>, details of a sewer camera developed by its National Building Research Institute.

This camera, comprising an 8mm cine camera and flash attachment with a single exposure device was a great advance in South Africa over the normal inspection methods using mirrors and the sun's rays.

It has, however, two disadvantages:

1. no results can be obtained until the film has been processed, and
2. the lack of visual monitoring does not enable on-site decisions to be reached.

Development of closed circuit television, the normal method used overseas, held out, albeit in a tantalising fashion, prospects of more effective inspection.

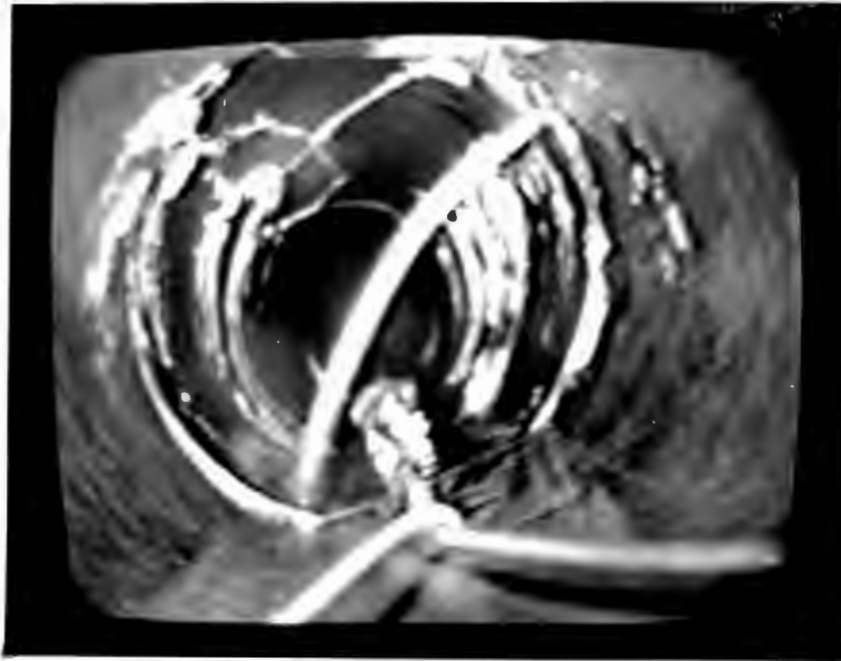


FIGURE 4: THE FIRST TELEVISED PICTURE IN SOUTH AFRICA OF A LEAK IN A SEWER - 225mm SALT GLAZED VITRIFIED PIPES, AUCKLAND STREET, PAARDEN EILAND.

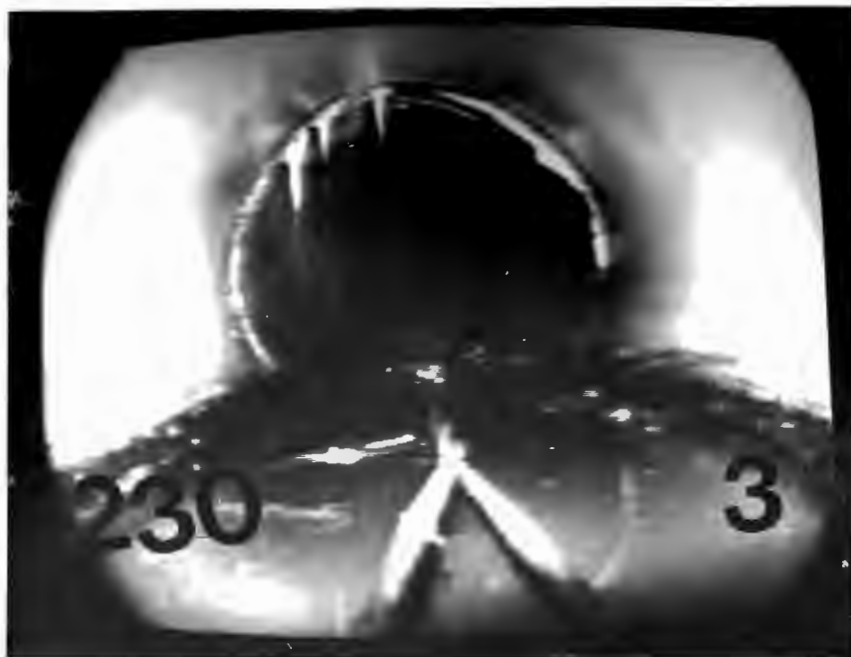


FIGURE 5: SEALING OF LEAKING JOINT BY SALTS IN GROUND WATER - 300mm SEWER, AUCKLAND STREET, PAARDEN EILAND.

Attempts to persuade local industry to provide a television inspection service did not meet with any success until late in 1970, when Messrs. TV Film Facilities (Pty.) Ltd., offered to provide such a service.

It was the author's privilege to participate in the pioneering of the system by providing in Cape Town, the necessary testing grounds and labour.

Figure 4, a still photograph of the television viewing screen, shows the first leak to be televised; this leak was previously photographed by the National Building Research Institute's camera.

The photograph has historic significance in that it was taken from the video-tape record of the very first use of closed-circuit television in South Africa for internal inspection of sewers.

Detailed examination of the video-tape record of the defect shown in Figure 4 reveals the cause: a 100mm connection was constructed (top left) by the well-established method of cutting a hole in the pipe with a hammer and cold-chisel preparatory to placing the saddle socket. During this operation the pipe was either cracked or weakened and cracks developed after backfilling of the excavation; these cracks have been sealed by salts in the ground water (white efflorescence) but damage to the joint has not sealed. The defective pipe is near the head of the sewer and is at reduced level -1,1 MSL (i.e. it is under the low water mark of Table Bay about 0,4 kilometre distant); the defect is the only one found in the 200 metres of sewer inspected in this area.

The use of the television camera is not without attendant difficulties, and it is essential to isolate and adequately to pre-clean an operational sewer before passing the



FIGURE 6: INDUSTRIAL DISCHARGE WITH  
DETERGENT - 300mm SEWER,  
AUCKLAND STREET, PAARDEN  
EILAND.

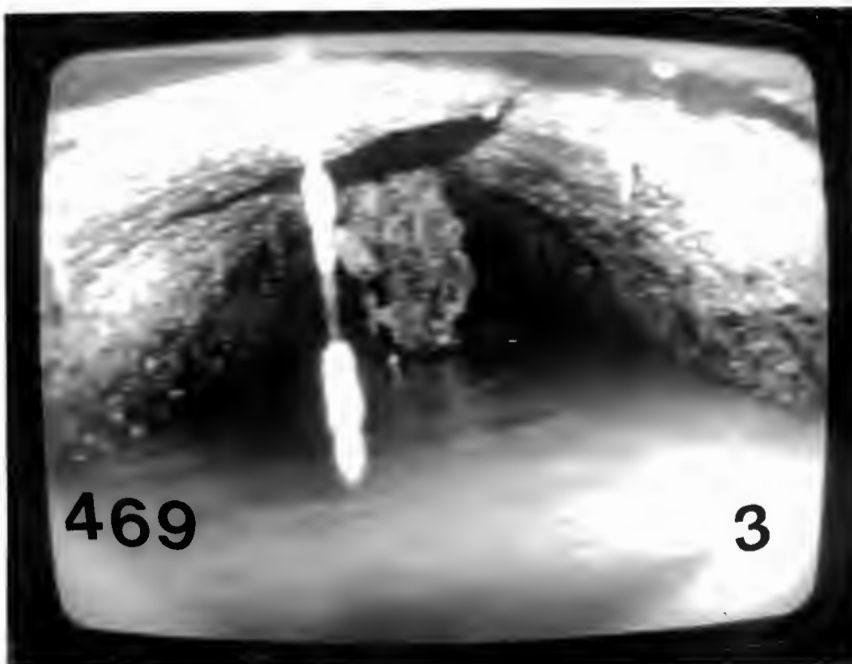


FIGURE 7: DETERIORATION OF SOFFIT OF SPUN  
CONCRETE SEWER BY SULPHATION,  
ENTRY OF ROOTS AND GROUND WATER  
- 530mm SEWER THROUGH PINELANDS:  
CAMERA FLOATED THROUGH.

the camera through.

This necessitates the diversion, from other work, of the essential labour and equipment, and the contracting firm has now included pre-cleaning as an extra service. Current costs are about R128,00 per 100 metres for inspection and R78,00 per 100 metres for pre-cleaning.

Large sewers can be inspected by floating the camera, but a head-room of not less than 265mm is necessary. Figure 7 shows sulphate attack on a 530mm diameter spun concrete sewer which has been in use for 20 years; roots have penetrated the soffit and there is active ground water infiltration leading to development of sink holes in the surrounding ground cover.

Additional services available are a video-tape record of any inspection required (this is invaluable where the need for remedial measures must be decided at managerial level) and photographic records of selected defects. Figures 3, 4, 5, 7, 8 and 9 illustrate typical defects or poor standards of construction in sewers and can be used for in-service training of personnel.

Figure 5 shows sealing of a joint by salts from saline ground water in a 300mm diameter sewer in Auckland Street, Paarden Eiland; this sewer, as well as that shown in Figure 4, consists of salt glazed vitrified clay pipes with mortar caulked joints. Both sewers have been in use about 25 years and the invert, Figure 5, is at a reduced level of -1,34 metres MSL - the ground water is virtually sea water.

Figure 6 shows, in the same area, a discharge of industrial effluent containing detergents; shortly afterwards the pipes were filled with foam and the camera had to be withdrawn. It is discharges of this volume that account for high peaks of

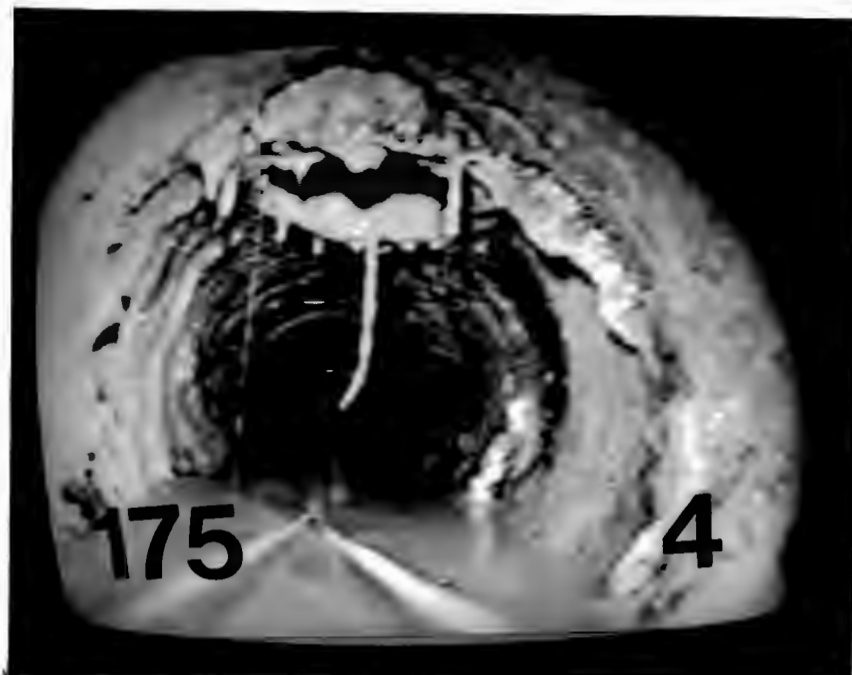


FIGURE 8: DEFECTIVE CONNECTION - STALACTITES RESULTING FROM INFILTRATION OF SALINE GROUND WATER. CONNECTION PROTRUDES INTO PIPE AND WILL HAMPER CLEANING OPERATIONS - 300mm SEWER, AUCKLAND STREET, PAARDEN E'ILAND.

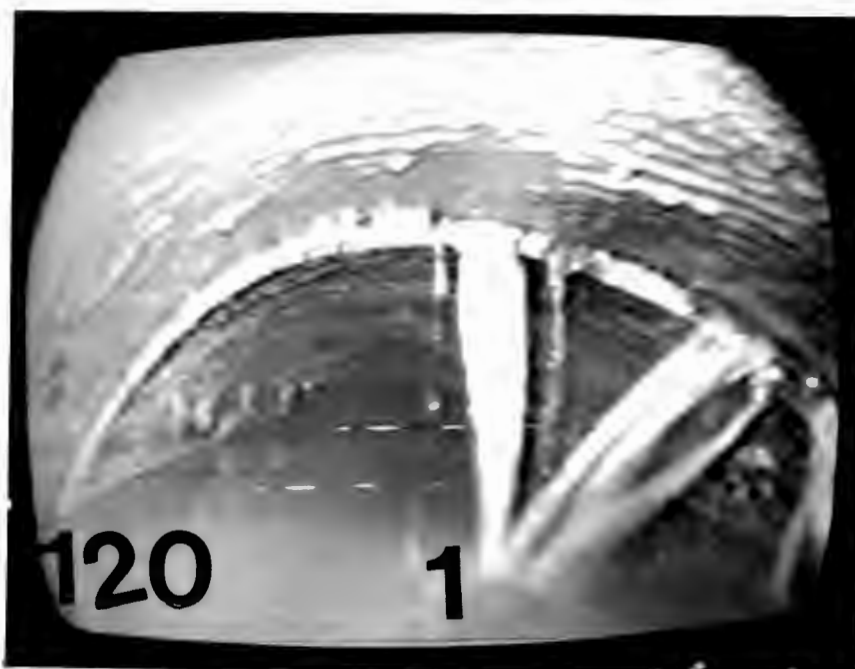


FIGURE 9: LEAKAGE AT RUBBERING JOINT IN A 680mm SPUN DOLOMITIC CONCRETE SEWER WHICH HAS SETTLED 1m BETWEEN MANHOLES DUE TO BAD SUBSOIL.

salinity during the day. (See Figures 16 and 26, Station 28 which show the variation in TDS concentrations in the same sewer).

Figure 8 taken in a 300mm diameter sewer in Auckland Street, Paarden Eiland, shows stalactites around a connection; these have formed as a result of ground water infiltration and the saline water has sealed the leaks around the saddle of the connection which is now virtually watertight.

Figure 9 shows active leakage in a 680mm diameter dolomitic spun concrete sewer with rubber ring joints which had settled about one metre vertically between two manholes 100 metres apart. The cause of the settlement was a low ground bearing resistance not apparent when the sewer (about 3 metres deep) was constructed; the internal inspection was carried out, prior to repairs, by floating the camera. This particular sewer was in Heathfield and does not fall within the scope of this thesis.

The preceding illustrations demonstrate the advantages of closed-circuit television for inspection and this service is now regularly used to inspect, after backfilling, sewers which have successfully passed a stringent hydraulic test of up to a 3 metre head of water.

Post-constructional acceptance of sewers built by contract is now becoming the accepted routine and this has met with opposition from contractors who claim generous infiltration allowances, usually quoted from American literature, in argument against rigid specifications.

Of the considerable length of sewers so far examined internally by this new method, very few major leaks have been encountered.

FIGURE 10:  
THE TELEVISION  
CAMERA ABOUT TO  
BE LOWERED INTO  
THE SEWER.



FIGURE 11: THE TELEVISION CAMERA BEING  
USED TO INSPECT 150mm SEWER  
PRIOR TO ACCEPTANCE FROM  
CONTRACTOR.

Figures 10 to 13 show the TV camera in use for internal inspection of sewers in a township constructed by a contractor of considerable experience.

The sewers under inspection are spigot and socket vitrified clay pipe with concentric factory-applied polyurethane joints. In spite of the high standards of construction a number of defects have developed after the hydraulic testing laid down in the specification and remedial measures have been called for.

It is the author's considered opinion that apart from occasional joint failures, the caulked joint has given less trouble than the more recently introduced rubber ring or polyurethane flexible joints. The mortar caulked joint was not sensitive to the high manufacturing tolerances permitted under South African Specifications; much smaller tolerances are essential for successful flexible joints and manufacturing standards must be raised.



FIGURE 12:  
MONITORING THE  
INSPECTION: THIS  
150mm SEWER HAS  
NO DEFECTS.



FIGURE 13: THE CAMERA AND CABLE COILED  
ON RACK IN PANEL VAN FOR  
TRANSPORTATION TO NEW SITE.

Chapter 9:            CONTROL OF INDUSTRIAL EFFLUENTS  
                          BY REGULATION.

In Chapter 2 reference was made to the Cape Town Municipal Drainage and Sewerage Regulations which are included in full as Table 2. These Regulations comprise the third tool used in the survey of mineralisation.

The Water Act of 1956 required all industrial undertakings then in existence to comply with the relevant requirements within a period of six months of the Act coming into operation. The author has been unable to find a single industry in Cape Town which has fulfilled its legal obligations.

It is surprising that even today very few industrialists are aware of their obligations under Sections 12 and 21(1)(a) of the Act; they thus render themselves liable to prosecution, for ignorance of the law is no excuse.

It is even more surprising that local authorities are not completely aware of the application of the act to their sewerage systems.

Cape Town found itself in the embarrassing situation of being in the stage of developing treatment works at Athlone designed on the Royal Commission of Great Britain Standards which are far less stringent in regard to effluents than the General Standards for the Republic of South Africa promulgated on 5th April, 1962<sup>(3)</sup>.

Attempts, in 1964, to introduce Municipal Regulations to restrict quality of effluents discharged to its sewers were abortive, partly because the local authority was reluctant to upset local industry by imposing restrictions affecting them financially.

The Council was under the impression, no doubt arising from industry itself, that factories could "up and go elsewhere" if the financial climate was unpleasant. This impression is,

of course, completely erroneous as both Sections 12(1)(a) and 12(1)(b) of the Act require permission from the State in respect of use of public water by industry and for the disposal of effluents and is applicable to the whole country and not to specific areas.

The only restrictions available were prohibitions contained in Section 180 of the Cape Municipal Ordinance No. 19 of 1951<sup>(15)</sup> which are not sufficiently specific; thus Industry continued to discharge effluents without any restriction in either quantity or quality.

During an investigation in the Paarden Eiland Area into the frequent flooding of one of the two sewage pumping stations, the author became personally aware of the fact that ONE industry alone was causing this overloading.

In 1968 the author took the necessary steps to inform the City Council on the need for regulations to control both volume and quality of industrial effluents and, in spite of opposition from industry, appropriate regulations were promulgated on 11th June, 1971.

The author and the Council's Legal Adviser were responsible for the text but Regulation No. 6 - "Prohibited Discharges into Sewers" was obtained from a specialist source.

Amongst the author's personal duties is the administration of the regulations and the four sets of forms included in Table 2 as Appendices 2A, 2B, 2C and 2D were drawn up to assist in this work.

The Regulations required all industries in operation on the "fixed date", viz. 11th September, 1971, to submit an application (Form 2A) for permission to continue to discharge

effluents into the municipal sewers.

Forms 2B (Rejection), 2C (Classification for use of water for domestic purposes only i.e. toilets, ablutions and incidental cafeterias), and 2D (Written Consent to Discharge Industrial Effluents) are now currently in use.

All industries are given a maximum of eighteen months from 1st January, 1972, to comply fully with the Regulations and are allowed rebates on the charges under Regulation 4 of 100%, 50% and, on special consideration, 25% for three consecutive cycles of six months. Thus by mid-1973 an effective control on discharge of effluents should be in operation.

Only on receiving analyses of effluents submitted with applications is it possible to gauge the mineral load contributed by industry; some typical analyses are given in Chapter 12.

The disregard for the community's problems is typified by the extremely high "waves" of TDS concentrations at Stations 25, 26 and 28; these are from fish and food processing industries. Figure 6, while illustrating the discharge of detergents, also illustrates the high volumes which cause the "waves".

The Department of Water Affairs regards the Cape Town Regulations as a model for the Western Cape and the same general text has been adopted by Goodwood and Parow, discharging to Athlone, and by Milnerton which has a separate sewer reticulation and treatment system to which Cape Town, Goodwood and Parow will discharge domestic effluents from portions of their respective areas in 1974.

It is yet too early to judge the impact of the Regulations on Industry in general but the response after notices had been served on individual industries has been gratifying.

Many firms have become conscious of the two main aims of the Regulations: (1) to conserve fresh water and (2) to reduce the polluting load.

For example, one firm producing premixed concrete when presented by the author with the problem of pre-treating alkaline effluent derived from the washing of its trucks, produced a novel solution in which all water used for truck washing will be passed through settling tanks and used for the same purpose or directed into production of concrete; even stormwater from the operating area will be used. This firm has, therefore, been classified as having a domestic effluent only.

Other industries are recycling part of their effluents, others are overhauling production processes.

Regrettably industries processing food, fish, milk and soft drinks find it impossible to practice any real economy in the use of water because of the danger of deleterious effects on their products. One soft drink firm after subjecting mains water to further treatment and sterilisation uses this product once only for pasturisation of containers and is then forced to jettison the entire volume. This water could probably be used to advantage by adjoining industries and this will be pursued in due course.

Air-conditioning plants using water are classified as "industrial" users of water; the effluents from such plants with evaporative cooling towers do not comply with the TDS uptake limitations of the "General Standards". These effluents are at present accepted into the sewers but on a temporary basis, to be reviewed annually. The author's personal opinion is that these effluents will have to be curtailed. These matters are discussed in Chapter 14.

Chapter 10:            FINDING MARKETS FOR SEWAGE EFFLUENT.

In common with other coastal towns and cities, Cape Town is in no position to return effluents to the streams from which the original waters were extracted.

The inland towns and cities can usually return a great deal of their spent waters to the rivers and the problems of finding markets for effluents does not arise.

In the case of Cape Town, which supplies water to some 15 other local authorities, the continual discharge of effluents to the sea is looked on askance by the Department of Water Affairs; and the Berg River farmers in times of water shortages, claim a priority in water allocations from the Wemmershoek Dam little realising that without the Dam there is no guarantee of the summer compensation flow in the river.

But unless markets are forthcoming, Cape Town must continue to discharge the major portion of its effluents to the sea.

Another factor is that the upland water resources of the Western Cape are by no means fully exploited. The development of these, in terms of current state policy, is delegated to the Department of Water Affairs and in terms of the Boland Water Project<sup>(16)</sup> the Cape Town Water Undertaking is to receive further allocations from the Riviersonderend/Berg Rivers Scheme which should suffice for estimated requirements to near the turn of the century. There is thus a reluctance to embark on expensive reclamation plants to produce what at best will be a less acceptable material in so far as the general public is concerned.

At this juncture I cite the case of the report "A Plan for Water Re-use"<sup>(6)</sup> submitted in July 1963, to the boards of directors of the sanitation districts of the Los Angeles

County, United States of America.

This report envisaged the reclamation and re-use of some 100 mgd of the 285 mgd of sewage effluent then being discharged to the sea. The other 185 mgd was of such high mineral content, generally caused by wastes of industrial origin, that some form of demineralisation would be required prior to general use.

This report was at the time widely acknowledged for its progressive approach to waste water treatment and re-use, but the projects recommended were never constructed. The greatest deterring factor was the imminent completion of the California Water Project scheduled to deliver water to Southern California by 1972. Water agencies reasoned that the full capacity of the new aquaduct should be utilised before the re-use of waste water because its cost would have to be met in full whether its full capacity was used or not.

The result of this was the study for a master plan to provide waste water treatment and disposal capacity beyond the turn of the century.

This plan envisages treatment at a joint water pollution control plant as well as trunk sewers and ocean outfalls.

The study revealed that there was a more economic approach to a large primary treatment facility; this was the construction of large secondary plants in the upstream areas of the system which could produce high quality effluents - but highly mineralised - which could be discharged to the sea via the river system, the solids being returned to the trunk sewers for treatment at the Control Plant.

The significant fact of this proposal is that tertiary treatment, including demineralisation, could be added at a later date when waste water re-use is considered again.

It should be noted that the major re-use of renovated water would consist of ground water recharge, irrigation, recreation and industrial application.

Ground water recharge is already practised in the State of California and such water is eventually withdrawn into the domestic system without tertiary treatment.

It should be recorded that the National Institute for Water Research is currently investigating ground water recharge in the Cape Flats.

With the Los Angeles concept in mind let us examine water quality criteria in the light of possible markets for renovated water in the Cape Peninsula.

Chapter 11:            WATER QUALITY CRITERIA.

The use of renovated effluents resulting from Cape Town's sewage treatment works can be grouped into four categories:

1. Irrigation.
2. Recreational uses (aquatic sports, bird sanctuaries).
3. Ground water Recharge.
4. Industry.
5. Potable supplies.

The specific problems likely to arise are discussed in some detail.

1.            IRRIGATION:

Sewage effluents have been used in Cape Town for irrigation purposes for over 50 years. The major use has been the irrigation of grass paddocks which were once regarded as valuable revenue-producing installations. Milk producing cattle have grazed on these lands and their products distributed and consumed apparently without any ill affect on either the animals or the public.

The nutrients present in the effluent produce a particularly lush growth of grass over the years and there is no evidence that the lands so used have become unusable due to the concentration of mineral salts.

This is probably due to two factors: (a) the indigenous grasses of the Peninsula, as well as the vigorous kikuyu, appear to have a high resistance to salinity and (b) the soils are sandy and the winter rains consequently have a beneficial effect in leaching out accumulated salts.

In more recent times, sewage effluents have been used after chlorination for irrigation of golf courses with equally good results.

The health authorities are opposed to use of effluents for irrigation of sports and playing fields unless they are subject to both sand filtration and chlorination. The main reason for this is the elimination of round worm ova and tetanus spores.

Consideration has been given to extending the use to vegetation planted for stabilisation of highway embankments and verges and the development of an effluent reticulation system throughout the Peninsula is a possibility; this could be extended to agricultural areas e.g. vegetable farms at Phillipi. Apart from the fact that such uses would be confined mainly to the dry months of the year - leaving an effluent to be disposed of during the winter months - a further deterrent is the possibility of deleterious effects on growth of trees, shrubs and edible crops.

It is extremely doubtful whether even as much as 10% of the total effluent available could be usefully diverted to agricultural purposes other than sportsfields and for similar purposes in the Peninsula itself.

It is possible, but hardly economic, to pump effluent to agricultural communities in the Stellenbosch and Paarl Divisions; consideration might be given to delivering this water to the Berg River and release the compensation water at present discharged from the Wemmershoek Dam. (See Chapter 14, Section 8.)

Whatever market is found, it is certain that waters with a TDS of 900 - 1000mg/litre would not be acceptable unless the chloride contents and sodium absorption ratio were kept below harmful limits.

Chlorides comprise roughly one-third of the TDS of the Cape Town effluents. In the case of the Athlone and the Cape Flats Treatment Works, the chlorides reach  $\pm 280\text{mg/litre}$ <sup>(7)</sup>.

It is certain that such concentrations would be harmful and in California<sup>(8)</sup> a chloride content of up to  $200\text{mg/litre}$  is considered acceptable; chlorides over this concentration are harmful.\*

2. RECREATIONAL USES:

There are extremely limited possibilities in view of the proximity of natural vleis and the sea; a possibility is a recreational area in the Black River valley damming up the effluent from Athlone. Bird sanctuaries are being developed and the oxidation ponds at the Cape Flats Works already attract bird life which had previously left the area.

3. GROUNDWATER RECHARGE:

This is currently being investigated by the National Institute for Water Research and is probably the most effective market if the TDS load in the effluent can be reduced.

4. INDUSTRY:

The high TDS load is a deterrent to industrial use; industry could better re-cycle within its own area of operation. The Athlone Power Station uses 10 Ml of effluent daily in cooling towers.

5. POTABLE SUPPLIES:

The Cape Town Municipality is currently negotiating an experimental plant with the Water Research Commission and the Council for Scientific and Industrial Research: the problem of mineral load remains.

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\*It should be noted that the effluent from the Pretoria - Witwatersrand - Vaal triangle complex proposed to be used for irrigation has a TDS of  $1400\text{mg/l}$  and a chloride content of  $4,2\text{m.e./litre}$  or  $150\text{mg/litre}$ .<sup>(17)</sup>

Chapter 12:            RESULTS OF INVESTIGATIONS IN AREAS  
                                  COMPRISING THE CATCHMENT OF THE  
                                  ATHLONE SEWAGE TREATMENT WORKS.

The Athlone Works receives sewage from three pumping stations.

1.            Langa Main Pumping Station: This, a major station at which operators are on continuous duty, was commissioned in 1954 and serves the northern, north-eastern and southern areas of the catchment detailed in Section (c) of this chapter.
2.            Raapenberg Pumping Station: This is also manned continuously; it serves the areas to the north-west, west and south-west of Athlone detailed in Section (d) of this chapter; this station commissioned in 1919 is to be replaced towards the end of 1972 by a new station of considerably greater capacity.
3.            Bokmakierie Pumping Station: A small station serving a portion of the southern areas draining to Athlone. It is automatically controlled and was built about 1932.

(a)            THE PRESENTATION OF RESULTS OBTAINED IN  
                                  ATHLONE CATCHMENT.

FIGURE 27\* shows the positions of sampling points numbers 2 to 28, 34 to 44, and 47 to 54, superimposed on a key plan of the various catchment areas; this plan also indicates the main sewers in the area investigated.

STATION 17 is at Camps Bay and was selected as being representative of a purely domestic sewage with little or no infiltration. STATIONS 45 and 46 are at Lakeside, the former serving a hospital for chest diseases and the latter a combination of 45 and a domestic area also of low infiltration.

The stations were selected in such a manner as to reveal abnormalities, if such exist, in a particular branch of the sewer

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\* At end of Thesis.

reticulation. Within limitations of time, equipment and personnel, abnormalities so far revealed will be further investigated.

The purpose of this initial survey was to assess the overall position in regard to areas generating a sewage of high mineral content.

TABLE 4 gives a brief description of the sampling stations.

FIGURES 14, 15, 16 and 17 show plotted, in bar chart form, the results of the investigations undertaken to the end of July, 1972. The shaded portions of the bars represent the maxima and minima of the TDS concentrations in milligrams/litre recorded at the stations for the period of the sampling, usually not less than 24 hours; and more often over 2 to 3 days.

Superimposed on Figures 14 to 17 are (1) the total daily flow in Megalitres (Ml) for the sampling period, (2) the Daily Load in tonnes and (3) the equivalent load in tonnes, supposing the area was one of purely domestic origin with a TDS of 300mg/l.

The difference between (2) and (3) thus represents a mineral load resulting from some "abnormality".

Except for Station 15, the results are plotted in serial order and do not represent a continuity of branch sewers. The appropriate combinations are made in the discussion.

The next phase of investigation in the areas studied will be the tracing and isolation of actual sources of the mineral load and the enforcement of the regulations for Industrial Effluent on individual offenders.

FIGURES 18, 19, 20, 21, 22, 23 and 24 show graphically the hourly variation in either TDS concentration, flow or load, or a combination of these factors.

TABLE 4

DESCRIPTION OF SAMPLING STATIONS (SEE FIGURE 27  
FOR LOCATION)

1. No data available.
2. 460mm: Epping Industria 1 Outfall Sewer.
3. 840mm: Northern Suburbs outfall sewer near Viking Way.
4. 530mm: Northern Suburbs outfall sewer near Goodwood Station.
5. 910mm: Langa/Kewtown/Wetton outfall sewer near Athlone Power Station.
6. 610mm: Sewer below Goodwood Metering Station.
7. 610mm: Sewer, Libertas Centre, Goodwood.
8. 225mm: Sewer, Alice Street, Goodwood.
9. 150mm: Sewer, Hamilton Road, Goodwood.
10. 380mm: Industrial sewer, Beacon Road, Parow.
11. 225mm: Sewer off Jan Smuts Street, Parow.
12. 530mm: Sewer off van der Stel Street, Parow.
13. Parow Metering Station.
14. 530mm: Sewer, Parow Street, Parow.
15. 150mm: Sewer, Parow North Golf Course.
16. 300mm: Sewer, 6th Avenue, Elsie's River.
17. 225mm: Sewer, Camps Bay Drive, Camps Bay.
18. 900 x 660mm avoid Maitland Outfall Sewer.
19. 1320mm: Liesbeek - Woodstock Outfall Sewer.
20. 1220mm: Maitland - Liesbeek - Woodstock Outfall Sewer.
21. 840mm: Black River Sewer.
22. Raapenberg Pumping Station.
23. 900 x 660mm avoid sewer, Upper Camp Street, Maitland.
24. 460mm: Sewer off Montagu Street, Maitland.
25. 300mm: Sewer, Carlisle Street Pumping Station, Paarden Eiland Industrial Township.
26. 300mm: Sewer, Carlisle Street, Paarden Eiland Industrial Township.
27. 150mm: Sewer, Dorsetshire Street, Paarden Eiland Industrial Township.
28. 225mm: Sewer, Auckland Street, Paarden Eiland Industrial Township.
34. 225mm: Sewer, Kensington Road, Kensington.
35. 225mm: Sewer, 10th Street, Kensington.
36. 300mm: Sewer, Acre Road, Kensington.
37. Dapperweg, Kensington.
38. 225mm: Sewer, Mossops Connection, Rondebosch.
39. 610mm: Sewer, Toll Road, Rondebosch.
40. 300mm: Sewer, Ohlssons Connection, Boundary Road, Newlands.
41. 910mm: Sewer, Durham Road, Mowbray.
42. 300mm: Sewer, Roberts Road, Salt River.
43. 1020mm: Sewer, Observatory Swimming Pool.
44. 460mm: Sewer, Barton Street, Woodstock
45. 300mm: Sewer, Westlake Avenue, Westlake (serves Hospital).
46. 380mm: Sewer, Uxbridge Road Pumping Station, Lakeside.
47. 380mm: Sewer, Justin Street, Rugby.
48. 225mm: Sewer, Mill Street, Rugby.

TABLE 4 (Continued)

49. 300mm: Ndabeni Industrial Township Outfall Sewer, Newway, Pinelands.
50. 380mm: Kensington Outfall Sewer, Avonduur, Pinelands.
51. 380mm: Pinelands/Ndabeni Outfall Sewer, Ringwood Drive, Pinelands.
52. 460mm: Sewer, Bokmakierie Pumping Station.
53. 530mm: Kensington Outfall Sewer, Ringwood Drive, Pinelands.
54. 1300 x 860mm: Langa Outfall Sewer (avoid)
55. 225mm: Bridgetown Outfall Sewer.
56. 680mm: Kewtown - Wetton Outfall Sewer.

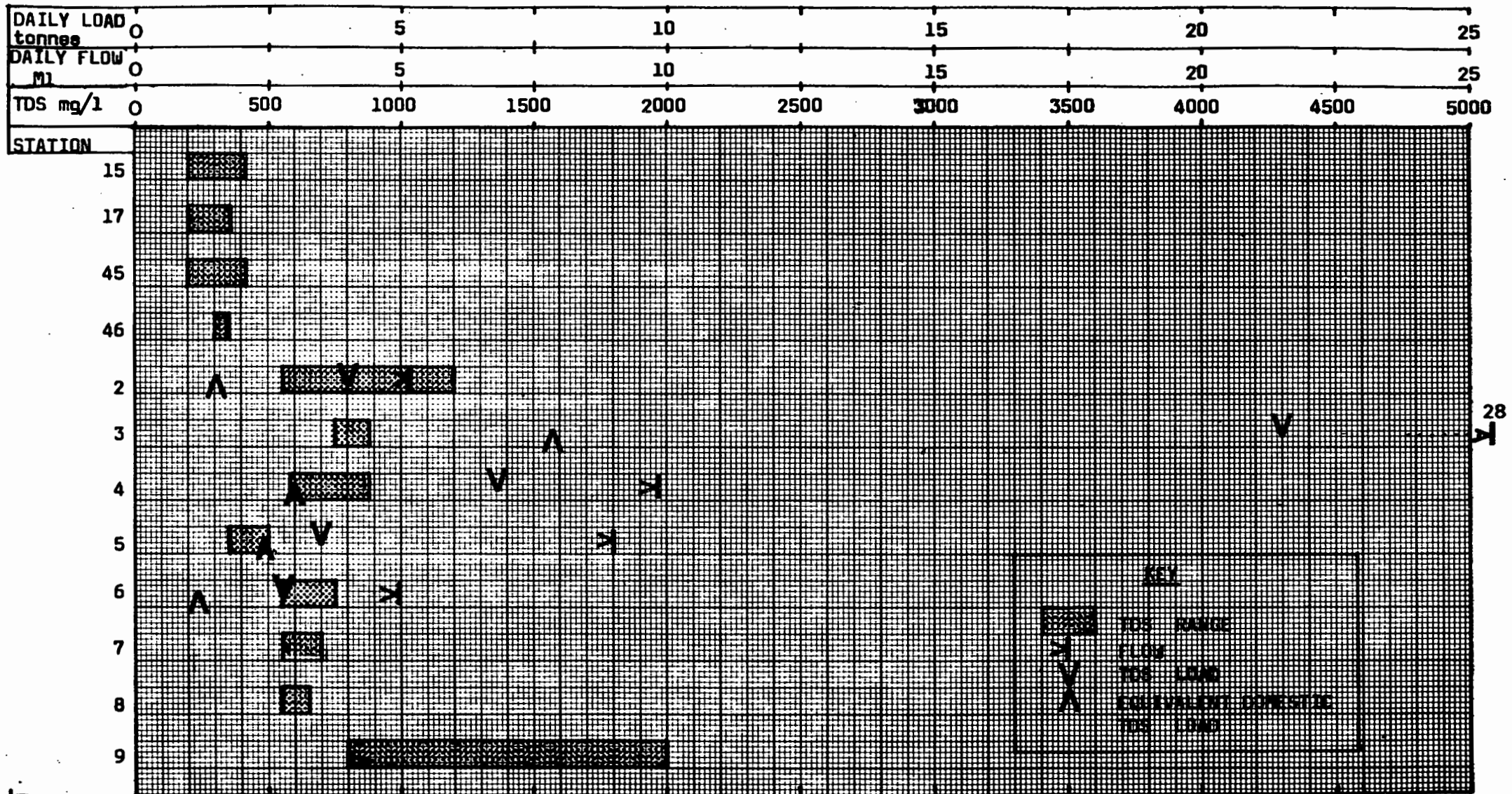
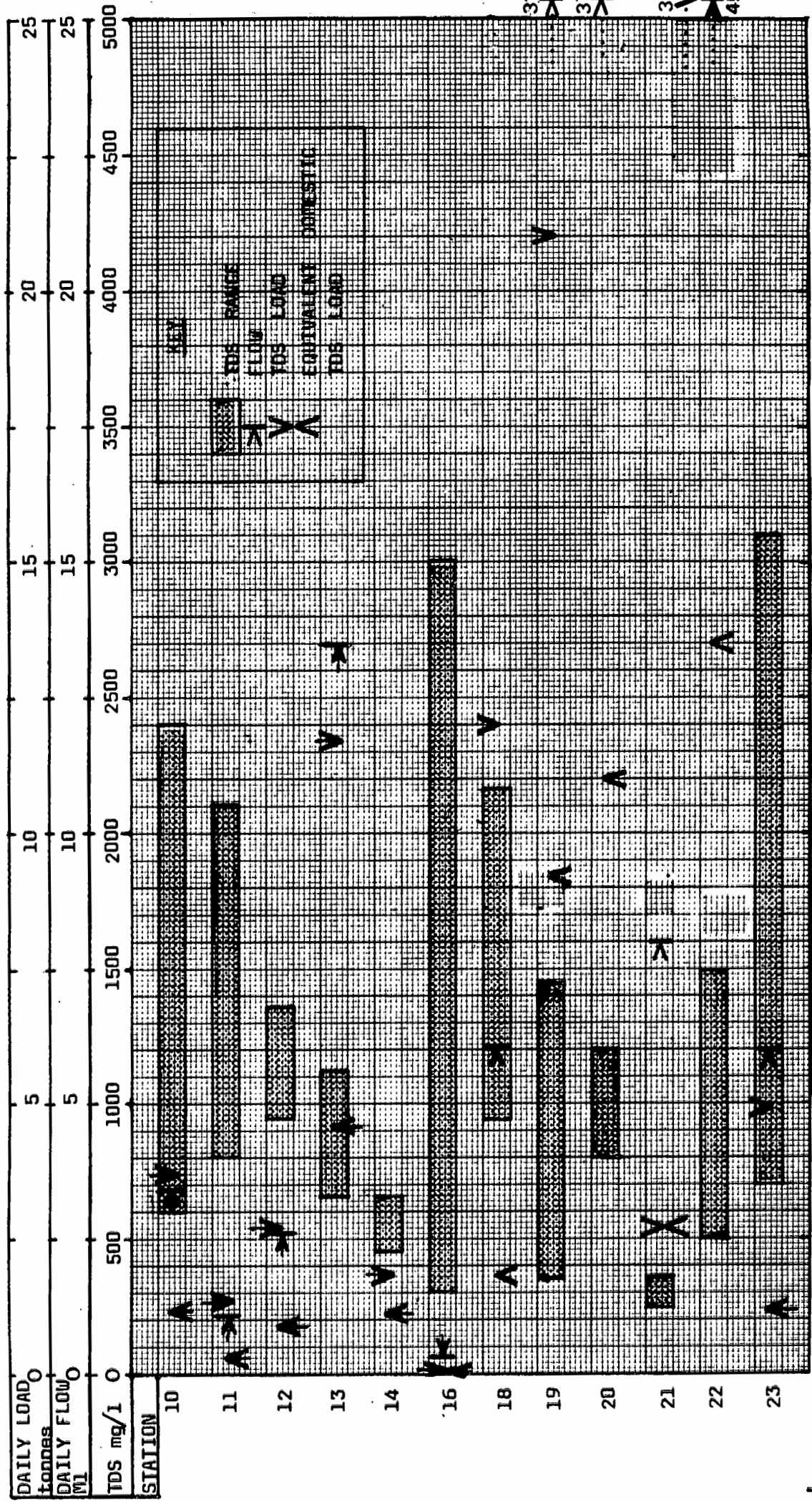


FIGURE 14.

COMPARISON OF TDS MAXIMA AND MINIMA, DAILY LOAD AND DAILY FLOW FOR STATIONS 15, 17, 45, 46 AND 2 TO 9.



COMPARISON OF TDS MAXIMA AND MINIMA, DAILY LOAD AND DAILY FLOW FOR STATIONS 10 TO 14, 16 AND 19 TO 23.

FIGURE 15.

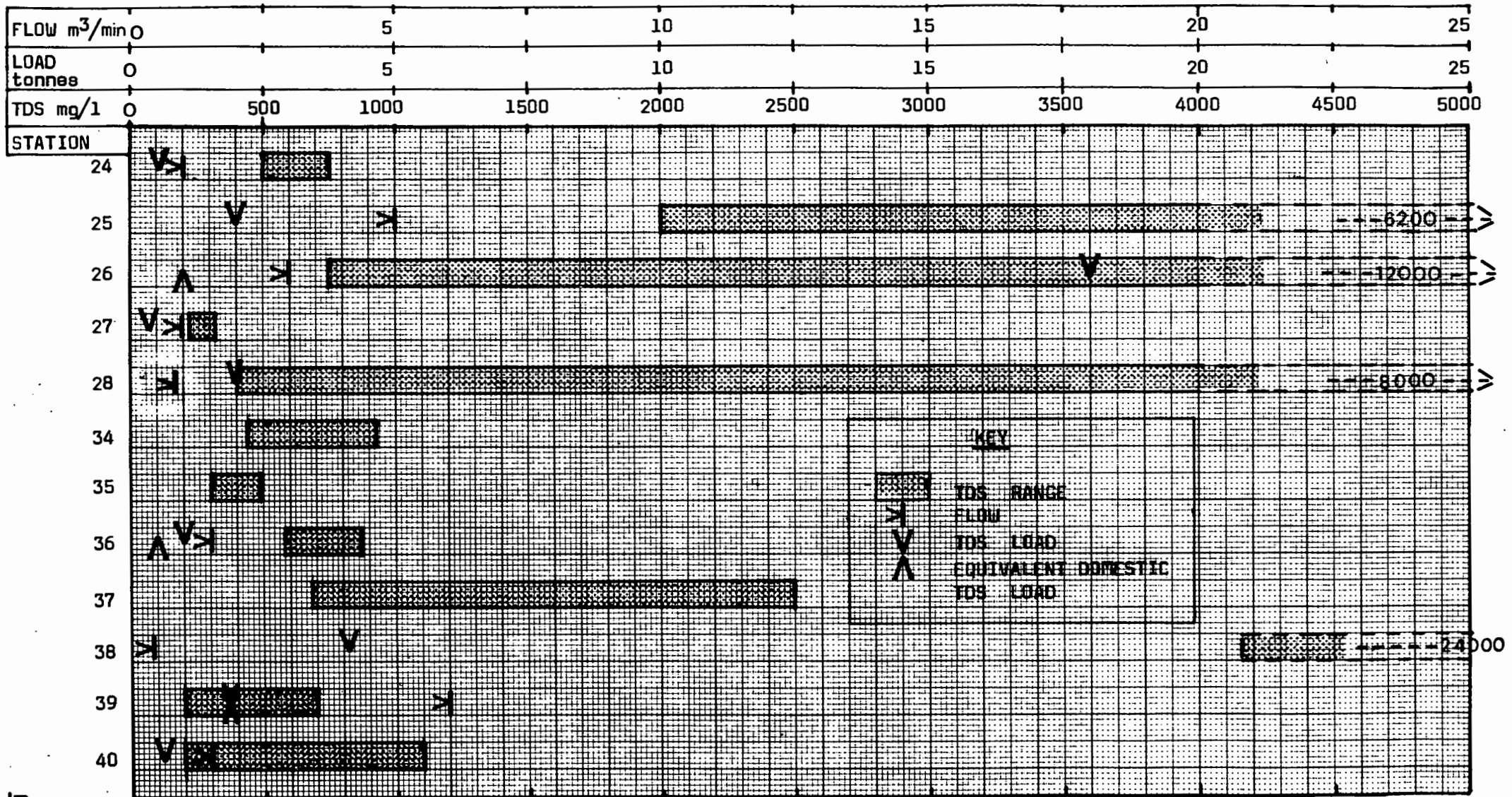
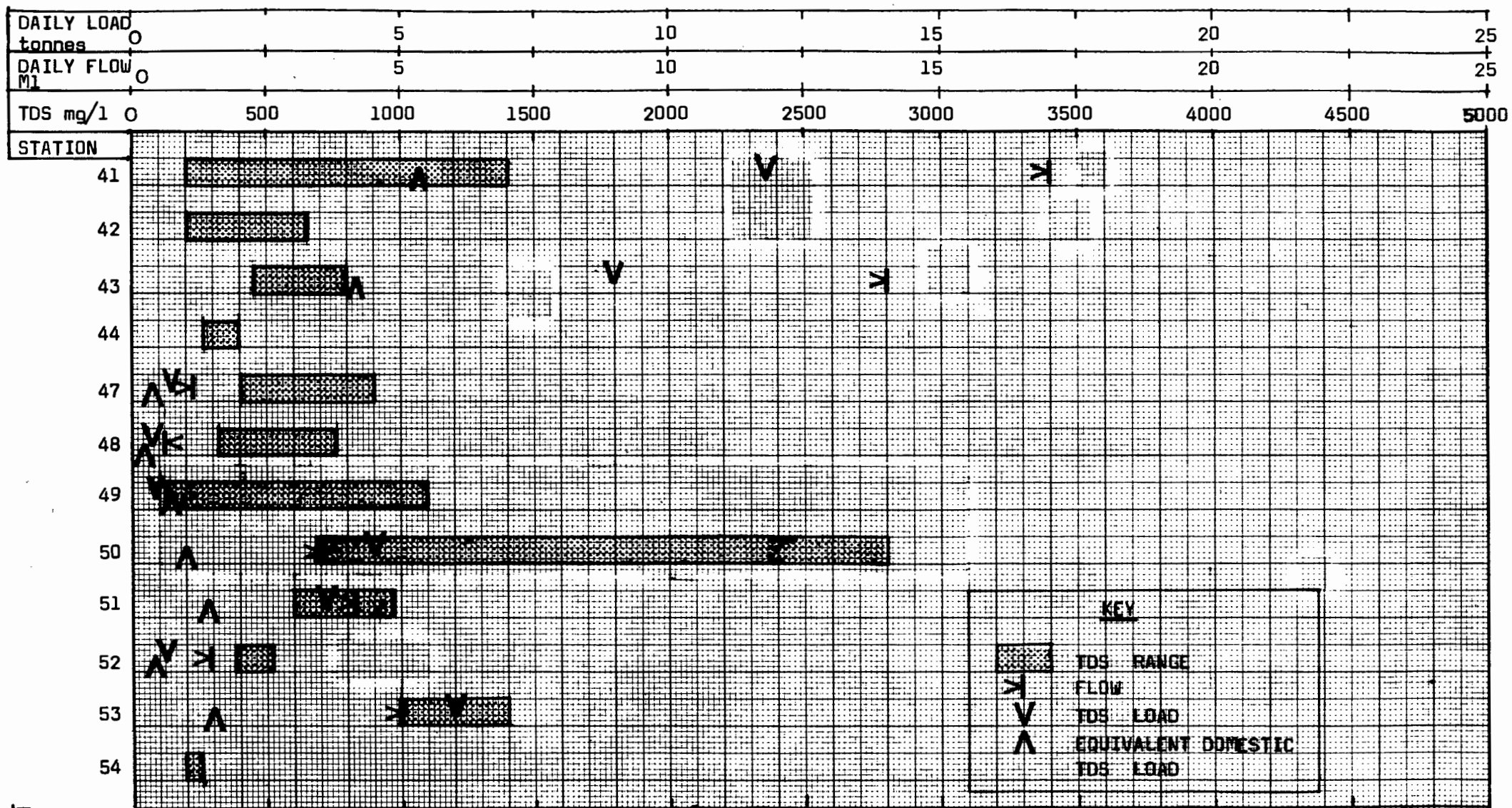


FIGURE 16.  
 COMPARISON OF TDS MAXIMA AND MINIMA, DAILY  
 LOAD AND DAILY FLOW FOR STATIONS 24 TO 28,  
 34 TO 40.



COMPARISON OF TDS MAXIMA AND MINIMA, DAILY LOAD AND DAILY FLOW FOR STATIONS 41 TO 47, 48 TO 54.

FIGURES 19, 20, 24 and 25 show superimposed data in respect of two or more stations which are either in series or which combine.

FIGURE 25 shows clearly how domestic effluents reduce the higher concentration from industrial areas.

The volumetric determinations for Stations 5, 18, 19, 20 and 53 were affected by the operating levels in the respective major pumping stations. The volumes have, therefore, been adjusted to tally with the metered flow to the Athlone Works.

(b) RESULTS OF SAMPLING IN RESIDENTIAL AREAS

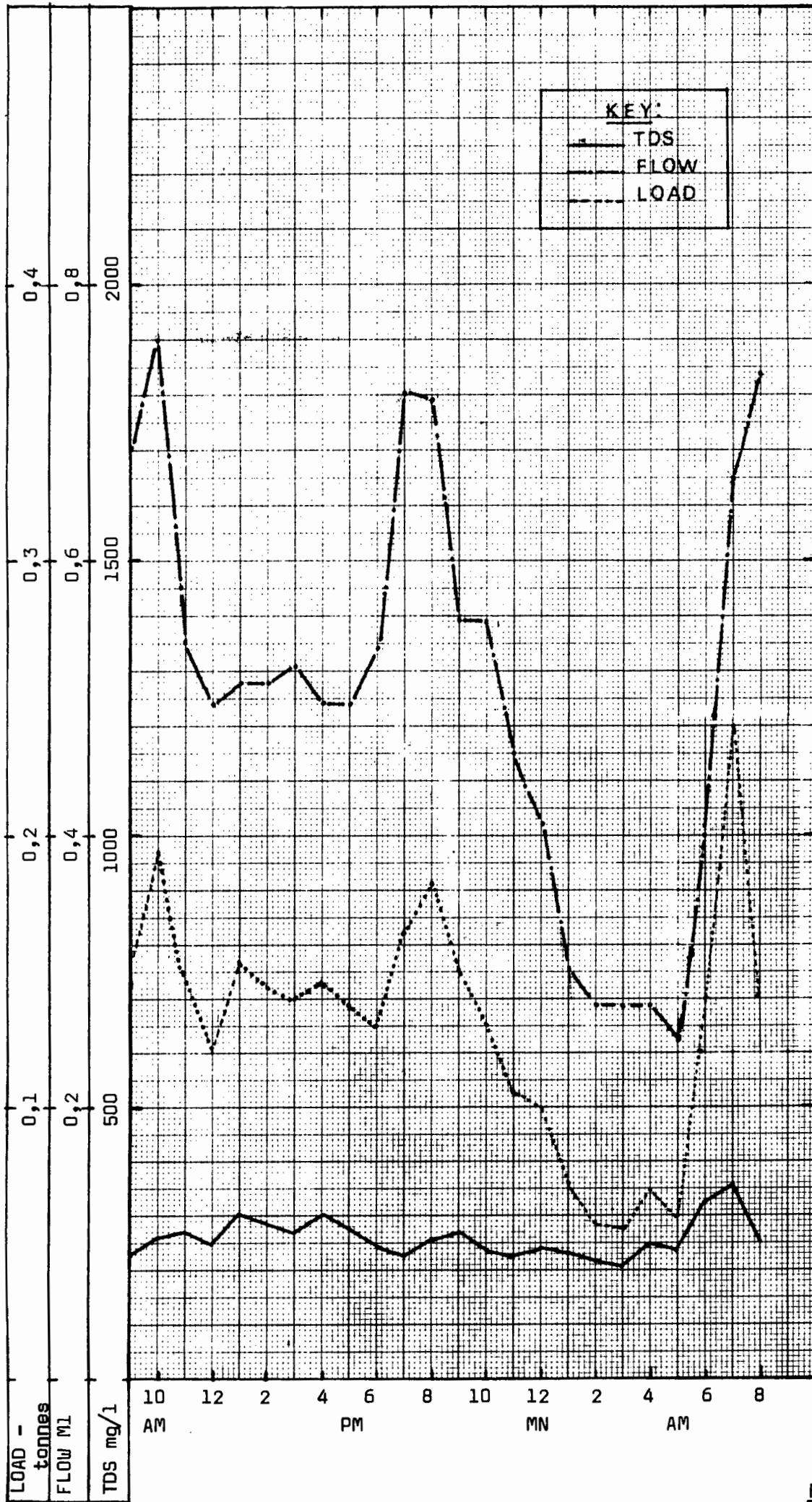
STATIONS 15, 17, 45 and 46 (Figures 14 and 18); except for numbers 45 and 46 these stations are completely unrelated.

STATIONS 15 (Parow) and 17 (Camps Bay) were, as stated in the previous section, selected as typical "domestic" areas with little or no infiltration.

The results of 24 hour investigations over several days at Station 17 are shown in Figure 18. The average TDS for a day was 257mg/l, with a range from 200 to 350. The rise in TDS concentrations towards 0800 hours is typical of a domestic residential area and can be accounted for by the normal activities of morning ablutions, use of toilets and cooking. There is an abrupt increase in flow from 0500 hours; and at the lowest flows between 0100 and 0500 hours there is no marked change in TDS - a confirmation of no infiltration when the TDS and flow fluctuations are considered together.

The low average TDS at Camps Bay is no doubt due to a higher water consumption per capita, than at Parow or Lakeside.

The Control Station at Parow, No. 15, shows a similar diurnal variation with a minimum TDS of 200mg/litre. As ground waters in this area are known to be saline, this low figure confirms that there is no measurable infiltration. However, the mean TDS is slightly



STATION 17: A TYPICAL DOMESTIC EFFLUENT FREE FROM INFILTRATION AND INDUSTRY.

FIGURE 18.

higher than that for Station 17; this can be accounted for by socio-economic factors leading to a lesser use of water per capita than at Camps Bay.

STATIONS 45 and 46: these two sampling points are at Lakeside, number 45 being on the sewer serving the Westlake Hospital, and number 46 at the pumping station serving the catchment area which is residential except for a bakery.

The diurnal range at the latter is remarkably low (257 - 307mg/l) and is no doubt due to the effects of Station 45, which has a fairly steady TDS, varying from 220 - 250mg/l and rising to the maximum at 7.00 a.m.

Thus a TDS concentration of 300mg/l can safely be used to indicate a "normal" domestic sewage.

(c) THE CATCHMENT OF THE LANGA MAIN PUMPING STATION.

This major installation presently constitutes more than half the sewage treated at Athlone and normally pumps about 50Ml of sewage a day.

Its catchment comprises the following systems:

- System 1. Epping Industria No. 1.
- System 2. Parow (industrial and residential),  
Goodwood (industrial and residential),  
Epping Garden Village, Thornton (both  
residential), the Conradie Hospital and  
the Cape Provincial Laundry.

The above two systems are collectively referred to as the "Northern Suburbs System".

- System 3. The Pinelands (residential) and Ndabeni (industrial) System
- System 4. The Kensington System (industrial and residential)

5. The Kewtown System (comprising Langa Bantu Township, Coloured Housing Schemes and the Athlone, Lansdowne and Wetton Areas Generally). The only industrial area is Nerissa (at Lansdowne).

The key sampling stations are respectively numbers 2, 3, 51, 53 and 5 in the order the catchments are given above.

The respective systems have been examined as follows:-

- (i) SYSTEMS 1 and 2. (Northern Suburbs System)

CONTROL STATIONS ARE NUMBERS 2 AND 3.

STATION 2 is on the outfall sewer serving the Epping I Industrial Township and the high salinities are accounted for by several industries including textile mills, several milk products factories, soft drinks, electroplating, yeast, etc. The diurnal curve shows several peaks including some during the low flow periods at night; there is every likelihood of infiltration in this Township the ground waters of which are highly saline.

Table 5 shows some of the sources of highly saline effluents and the concentrations revealed in this area in the initial enquiry under the Council's Drainage and Sewerage Regulations which became effective on 11th September, 1971; as stated in Chapter 9, all industries then existing have a maximum of 18 months from 1st January, 1972 to comply with the restrictions given in Table 1.

TABLE 5

<u>Type of Industry.</u>	<u>TDS</u> mg/l	<u>Chlorides.</u> mg/l	<u>Sulphates.</u> mg/l	<u>Sodium</u>
Production of oxygen, nitrogen, carbon dioxide, acetylene.	153000	42	trace	63000
Yeast manufacture	37000	not determined	2450	
Furs & Skin processing	10000	4500	300	
Textiles - dyeing	5300	1850	430	950

The TDS range is 550 to 1200mg/l with a mean of 770, the daily flow 5,2Ml and the daily load 4,0 tonnes; the equivalent "domestic load" is about 1,5 tonnes indicating that sources of salinity must be investigated.

STATION 3 is on the outfall sewer serving Goodwood and Parow, which have industrial areas, Thornton and Epping Garden Village (residential), the Conradie Hospital and the Cape Provincial Laundry, and is the continuation of Stations numbers 4, 6, and 9 to 16.

The TDS concentrations vary between 670 and 870mg/litre, the higher figure occurring at low flow; with a mean of 760mg/litre the total daily flow at this station is 28Ml and the mineral load is 21,5tonnes; the equivalent domestic load is about 8,4 tonnes which indicates abnormalities to be investigated.

#### STATIONS 6 AND 4.

STATION 6 is representative of the residential and business area of Goodwood and reflects Stations numbers 7, 8 and 9.

Station 6 itself shows a TDS range of 550 to 750mg/litre which is maintained by numbers 7 and 8; number 9 shows an even higher range of 800 to 2000.

The hourly concentrations for Station 9 are superimposed on Figure 19, which covers Station number 36.

The flows for Station 9 are small, averaging 0,05 m<sup>3</sup>/minute; the TDS load is thus small but the ground water TDS concentration was found to be 7000mg/litre; the infiltration represents about 10% of the flow.

It is quite clear that the TDS load on Station number 6 is mainly from infiltration and that the area around Station 7 is the main concentration. The flow is 5Ml, and the load 2,8 tonnes - the equivalent domestic load is 1,5 tonnes indicating nearly 4Ml of infiltration.

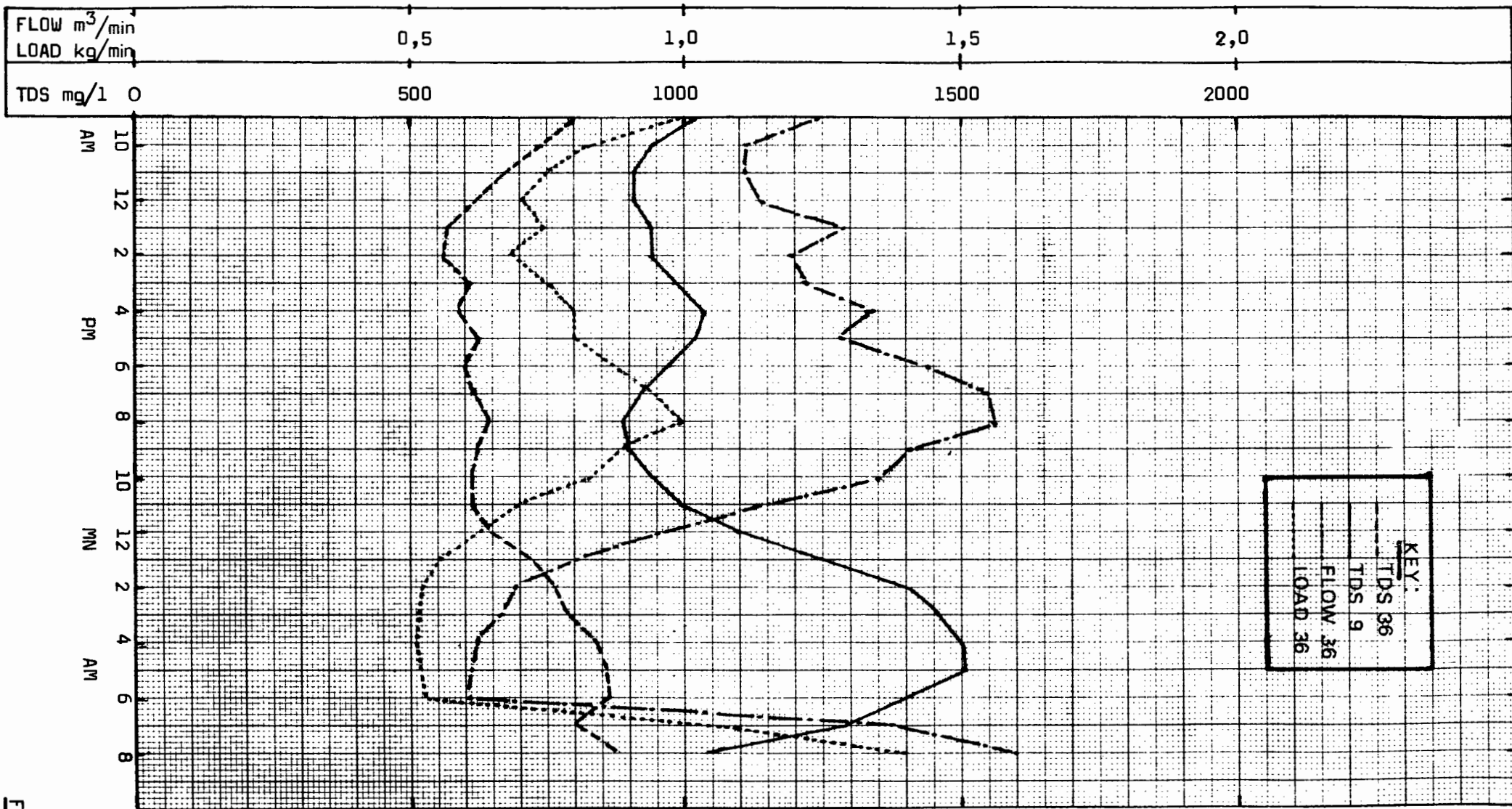


FIGURE 19.

STATIONS 9 AND 36: HIGHLY SALINE EFFLUENT FROM DOMESTIC AREA DEMONSTRATING INFILTRATION OF SALINE GROUND WATER - IN THE CASE OF STATION 9 - 7000mg/litre

STATION 4 is on the sewer serving Elsie's River (Goodwood) Industria (Number 16) and Parow (Numbers 10 to 15). Here there is a flow of 9,8Ml contributing a load of 6,8 tonnes, which means an abnormality of 3,9 tonnes.

STATION 16 shows a large daily range of TDS - from a minimum of 350 to a maximum of 3000mg/litre, the latter occurring as a single peak. This is clearly an industrial source but the flow load contributions are low; there is little or no infiltration.

#### THE PAROW COMPLEX (Numbers 10 to 15)

STATION 15 (Parow Residential) has already been discussed and is one of the "domestic" control stations.

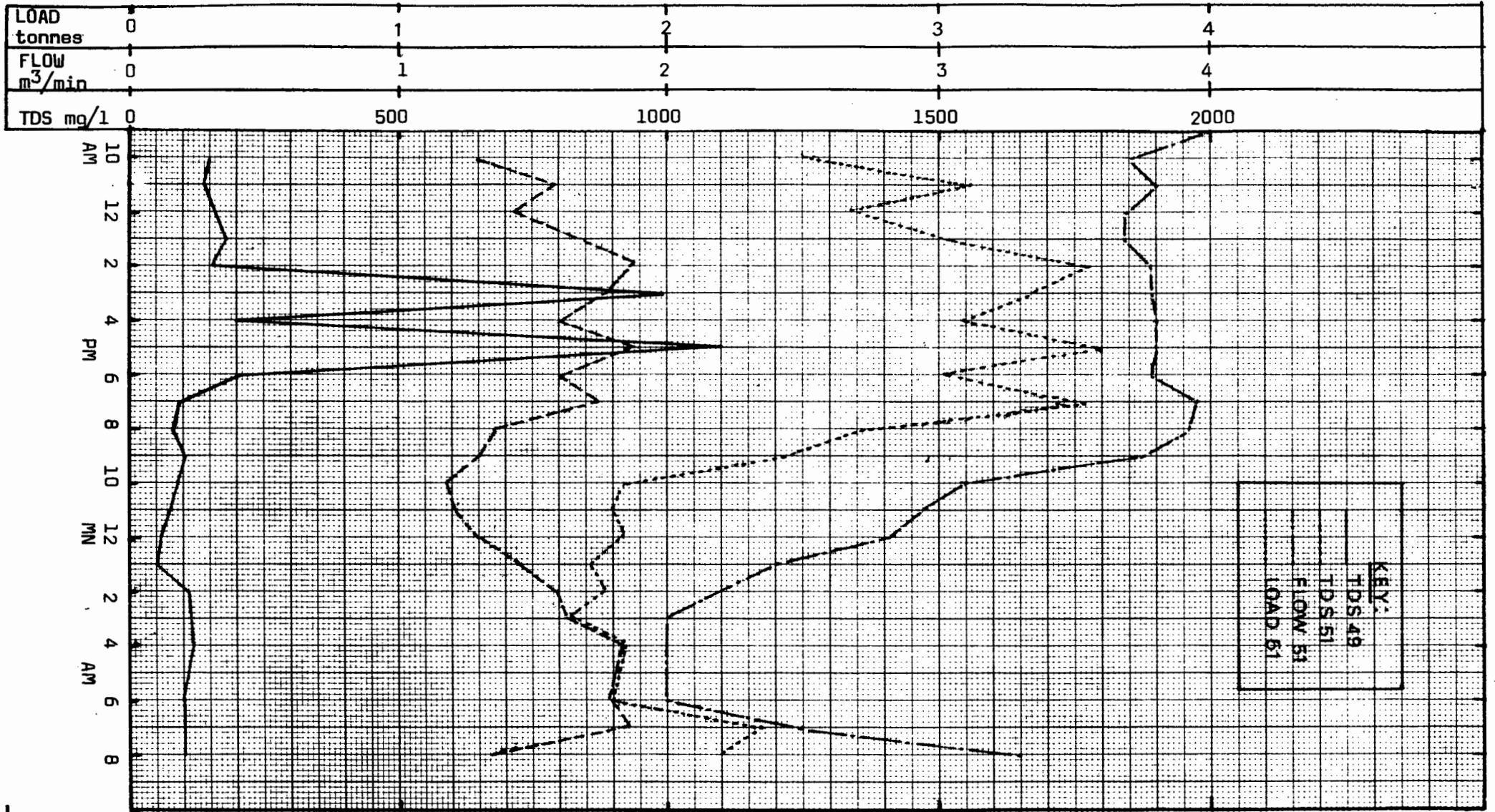
STATION 13 represents the combined flow of the Parow sampling stations; the average TDS concentration is 750mg/litre and the flow 9 m<sup>3</sup>/minute; giving a daily flow of 13,5Ml and a TDS load of 11,7 tonnes; as the equivalent "domestic load" from this area would be about 4,0 tonnes, there is an "abnormality" of nearly 8 tonnes a day. The high loading is accounted for by small volumes of highly waste liquors containing high concentrations of sulphates and phosphates.

Furthermore, the diurnal variation of TDS at Station 13 shows the lowest concentrations during the daylight hours and a rise at night. This phenomenon illustrated in Figures 19, 20 and 21 demonstrates how highly saline flows are diluted by sewage from domestic sources.

STATIONS 10 AND 14 are representative of ground water infiltration, while STATIONS 11 and 12 reflect industrial effluents, although there is also evidence of infiltration.

#### Conclusions in respect of discharges from the "Northern Suburbs System."

The total load at Station 3 is 21,5 tonnes; the sum of loads at Stations 4, 6, 13 and 16, which are the collecting stations for their



STATION 49 (INDUSTRIAL) SUPERIMPOSED ON STATION 51 (INDUSTRIAL AND DOMESTIC) SHOWING THAT HIGH NIGHT SALINITY IS INFILTRATION OF SALINE GROUND WATER.

FIGURE 20.

areas, is also approximately 21,5 tonnes. This clearly indicates that there is no major abnormality on the long length of sewer between Stations 3 and 6 and that the contributions from the domestic areas of Thornton, Epping Garden Village and from the hospital and laundry are normal.

The mineral load from the northern suburbs system is this primarily due to infiltration and industry in Goodwood and Parow and Epping and amounts to some 25 tonnes daily in a flow of approximately 33ML.

Compared with the normal domestic load (9,9 tonnes) it is quite apparent that Northern Suburbs System requires further detailed examination both for industry and infiltration.

(ii) SYSTEM 3 (Pinelands and Ndabeni).

There are two sampling stations, numbers 49 and 51 on this system and the data is illustrated in Figures 17 and 20.

STATION 49 reflects the Ndabeni Industrial Township and STATION 51 both Ndabeni and Pinelands; the diurnal variations are shown in Figure 20 and the ranges and contributions in Figure 17.

Examination of data from number 49 shows very low TDS concentrations at night - dropping to as little as 60mg/litre and averaging about 100mg/litre; day-time peaks of up to 1200mg/litre were recorded.

The conclusions reached for Station 49 are: (1) industrial discharges by day and (2) wastage of water at night, probably from toilet and ablutions facilities in the factories and possibly cooling water as well. These aspects will need further investigation.

STATION NO. 51: the salinities are high, ranging between 600 and 950mg/litre; the day time distribution is indicative of pollution by industry to such a level that the more dilute domestic flow is masked.

As the industrial flow drops at night, the TDS concentrations increase, clearly demonstrating infiltration. The ground waters at Pinelands are known to have high TDS values, reaching 3000mg/litre.

The flow from this system is about 4,5Ml and the TDS load 3,5 tonnes. With an equivalent "domestic" load of 1,3 tonnes, the Pinelands section of this system needs detailed inspection to trace infiltration.

(iii) THE KENSINGTON SYSTEM.

Five sampling points were established on this system: Numbers 53, 50, 35, 36 and 37 (Figures 16 and 17).

STATIONS NUMBERS 35 AND 36 are in residential areas and STATION NUMBER 35 shows TDS concentrations averaging 480mg/litre. While this is higher than the norm established for Stations 15, 17, 45 and 46, it can be accounted for by socio-economic factors as the TDS drops at night to nearly 300mg/litre. Groundwater salinities are known to be higher than this figure; unfortunately flow data is not available, so that the extent of infiltration must still be determined.

The data at Station 36 (Figure 19) shows the typical infiltration patterns: high TDS concentration at night, falling by day. With a TDS range of 570 - 870mg/litre and a flow of about 1,5Ml, the mineral contribution is not, however, significant.

STATION 37 for which unfortunately no flow data is available, illustrates the diurnal variation in an industrial area - TDS range is 2450mg/litre by day dropping to 680mg/litre at night.

STATIONS 50 AND 53: these stations are on the main outfall from Kensington.

While STATION 50 has a larger range of TDS (680 to 7800mg/litre) than number 53 (1000 to 1400mg/litre) there are no contributing sewers between them but there is an increase in flow with a considerable increase

in Daily TDS Load (4,5 to 6,0 tonnes and flow 3,6Ml to 5,0Ml).

Figure 7 illustrates soffit failure on this sewer at a point between the two stations and shows root and ground water penetration. This 530mm diameter sewer is of spun concrete and was laid about 1951. The television inspection followed a collapse of the top of the sewer in two places and confirms that the deterioration is due to sulphation. The sewer is to be renovated in the near future using a high density polyethylene liner. This system requires both industrial and infiltration checks.

(iv) THE KEWTOWN SYSTEM.

Four Stations were established as follows:

Number 5 (whole flow), Number 54 (Langa Bantu Township), Number 55 (Bridgetown) and Number 56 (Kewtown - Wetton).

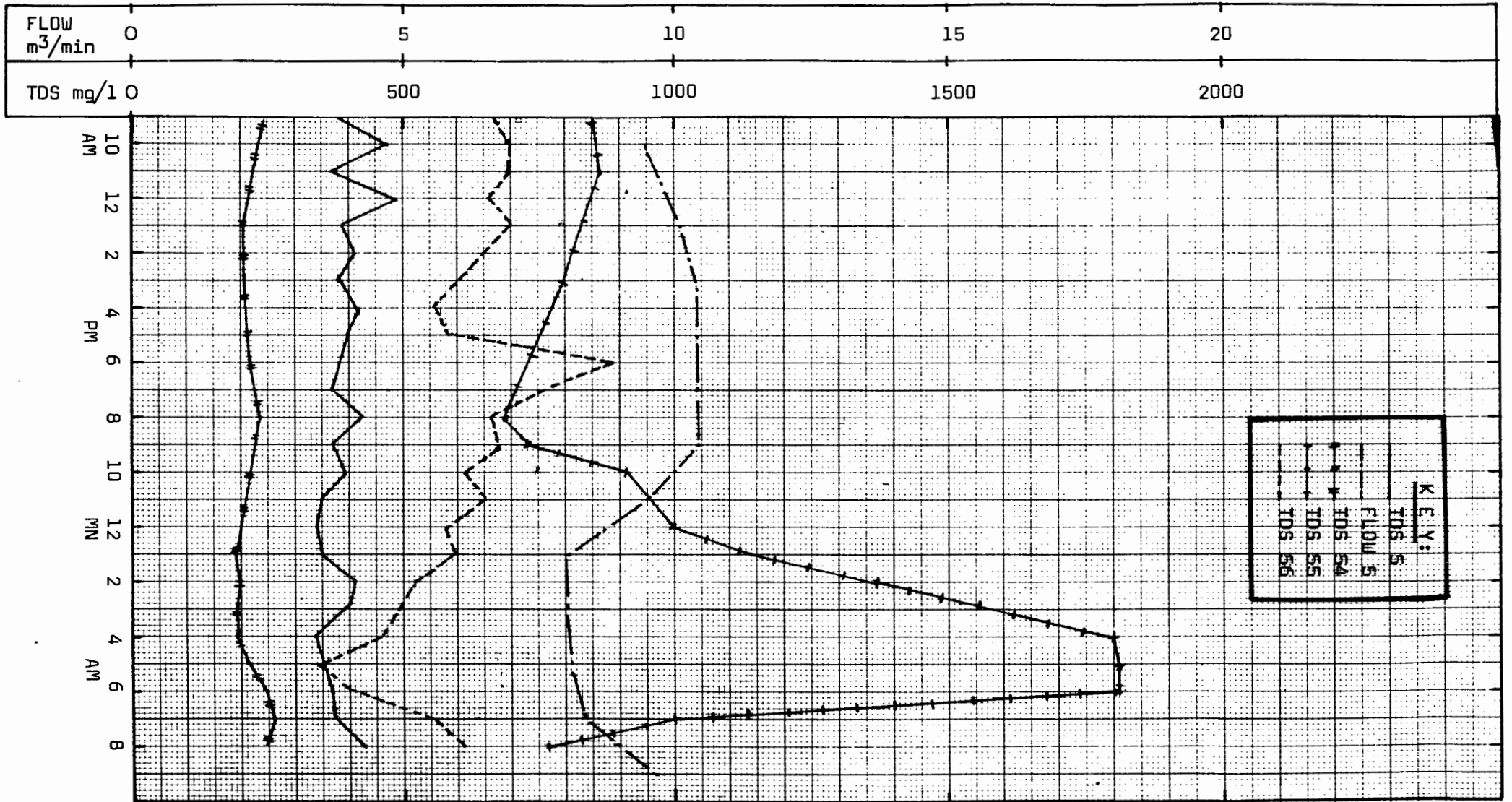
The latter two stations are not included in Figures 14 to 17 but the diurnal data is shown in Figure 21; and ranges for Stations 5 and 54 are on Figures 14 and 17.

Station 5 was later resampled with similar results to those shown on Figures 14 and 21.

The slightly higher average TDS of 390mg/litre could be ascribed to socio-economic conditions as the concentration is lower at night than by day.

However, STATION 54 (Langa Bantu Township) constitutes a low-salinity flow, with a range of 200 to 250mg/litre due to an abnormally high discharge (wastage) of mains waters; in addition while night flow TDS concentrations are low for Station 56, the daily flow shows much higher concentrations with peaks suggestive of locally high saline discharges.

STATION 55 (Bridgetown) quite clearly has an abnormally high TDS concentration together with very high peaks to  $\pm$  1800mg/litre



STATION 5 SHOWING TDS DILUTION BY SEWAGE FROM STATION 54 (BANTU TOWNSHIP). NOTE HIGH NIGHT TDS, AT LOW FLOWS, AT STATION 55.

FIGURE 21.

between 9.00p.m. and 8.00 a.m. daily. The regularity of this occurrence over a three day sampling period is significant and is quite clearly due to ground water infiltration; the flow is very low (0,17 m<sup>3</sup>/minute) in comparison to the other contributing sewers.

Stations 5, 55, 56 and 57 are plotted for comparison on Figure 21. The corrected daily flow from this system is 9Ml, the load 3,5 tonnes and the TDS range 375 to 500mg/litre.

As the equivalent domestic load is 2,4 tonnes this system does not appear to require further investigation. However, a reduction of water consumption at Langa would undoubtedly change the picture and the Bridgetown area certainly needs attention.

(v) CONCLUSIONS REACHED IN RESPECT OF THE LANGA MAIN PUMPING STATION CATCHMENT.

With adjustments to correlate with the total flow through the pumping station the daily mineral loads and flows can be summarised as follows:

TABLE 6

<u>Sampling Station</u>	<u>Daily Flow - Ml</u>	<u>Mineral Load - Tonnes</u>		
		<u>Actual</u>	<u>Equivalent Domestic</u>	<u>Difference</u>
2	5	4,0	1,5	2,5
3	28	21,5	8,4	13,1
51	4	3,5	1,2	2,3
53	5	6,0	1,5	4,5
5	9	3,5	2,7	0,8
	51	38,5	15,3	23,2

With the exception of System 5 (represented by Station 5) all the contributing areas require more detailed investigation to trace both infiltration and industrial salinities; portion of System 5 - Bridgetown - contributes salinity by infiltration.

It should be noted that the residential areas of Goodwood, Parow, Kensington, Pinelands and Bridgetown contribute a mineral load due to infiltration.

There is evidence of infiltration in all industrial areas except that of Ndabeni.

(d) THE CATCHMENT OF THE RAAPENBERG PUMPING STATION.

This station, erected in 1919 is shortly to be replaced by a modern unitised installation.

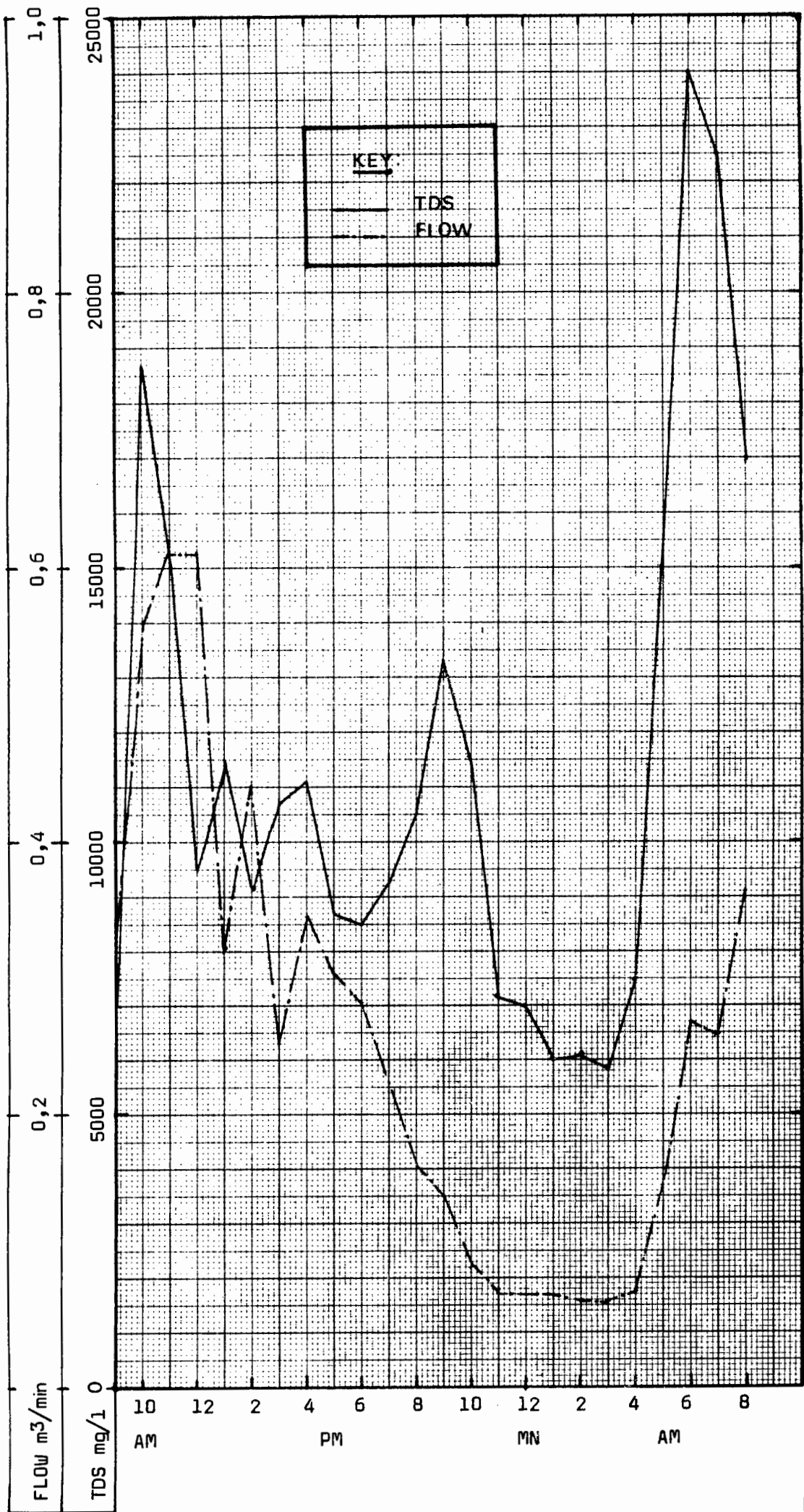
The catchment was extended beyond the original area by the inclusion of the Paarden Eiland Industrial Township, Rugby and Tijgerhof; subsequently the Langa Bantu Township was diverted to Langa Main.

The Raapenberg Pumping Station was designed to store 4,5Ml/day in tanks and the pumping capacity was eventually increased to some 45Ml/day.

The Athlone "A" works was constructed circa 1940-1945 to release the original treatment site for housing purposes. The "A" works was designed to serve the Raapenberg and Bokmakierie Stations and to treat a normal 27 megalitres per day, dry weather flow, but excess flows are diverted to the "B" works which is also overloaded and the new pumping station will aggravate the position. Provision has, therefore, been made to divert up to some 54Ml/day to the Cape Flats works.

The catchment of the Raapenberg Station comprises the following systems:

1. The Liesbeek System, primarily residential but containing two major polluting industries.
2. The Mowbray - Woodstock System, comprising residential and industrial areas.  
These two systems combine at Valkenberg.
3. The Black River System, which is entirely residential.
4. The Maitland System, which includes Paarden Eiland (industrial), Rugby, Brooklyn (both residential) and Maitland (residential and industrial - the latter containing heavy pollutions, including the abattoir).



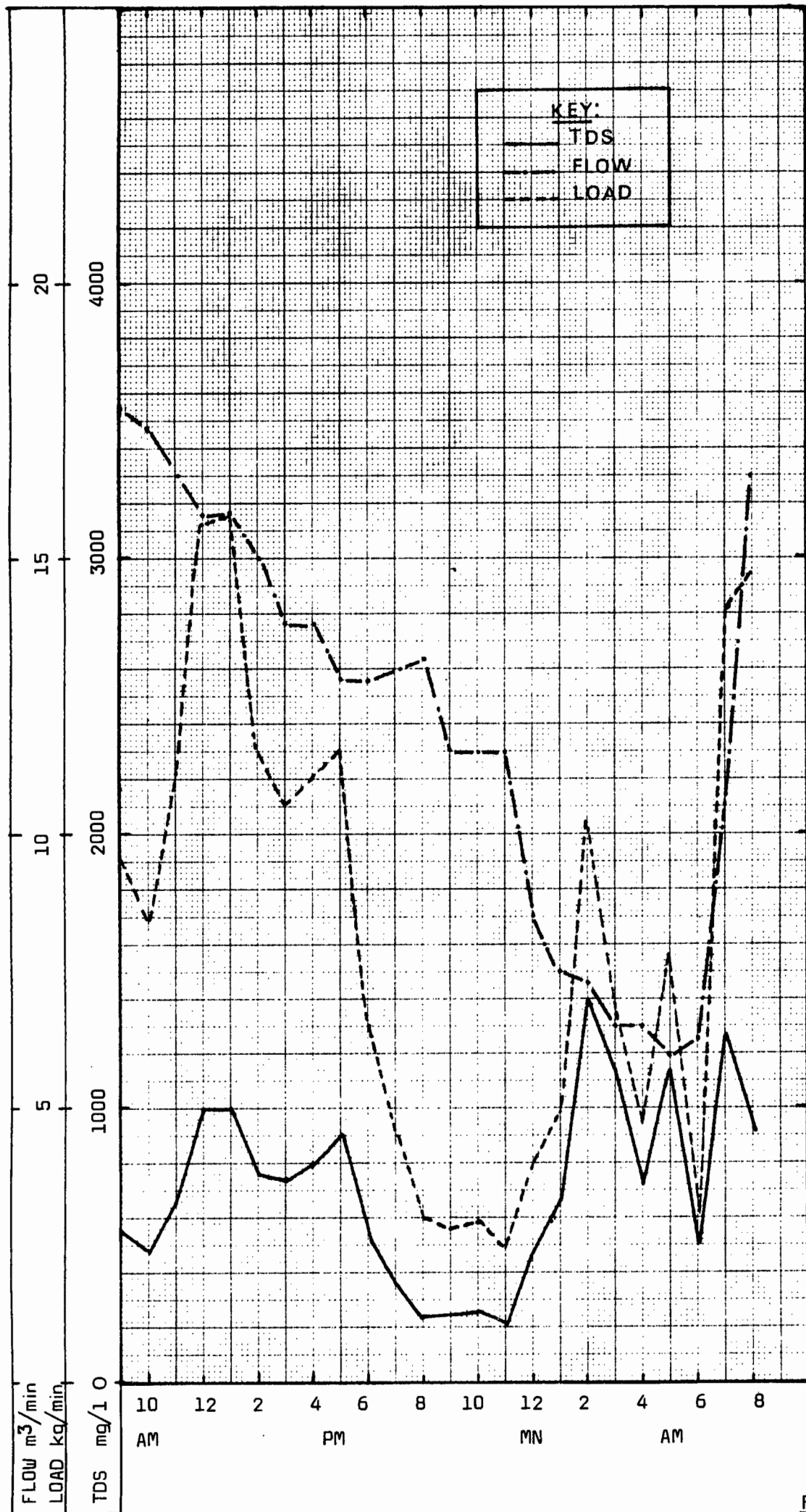
STATION 38: TANNERY EFFLUENT

FIGURE 22.



STATION 40: BREWERY DISCHARGE.

FIGURE 23.



STATION 41: THE EFFECT OF DILUTION BY DOMESTIC SEWAGE ON BREWERY AND TANNERY EFFLUENT.

FIGURE 24.

The key sampling stations for the above systems are respectively - 41, 43, (41 + 43 = 19), 21, 18, 20 (18 + 19 = 20) and 22.

(i) The Liesbeek System

Samples have been taken at four stations, 38 to 41; of these number 38 is a tannery (Figure 22) and number 40 a brewery (Figure 23).

The lowest station in the system, number 41 (See Figures 17 and 24) represents the Liesbeek System before it combines with the Woodstock System.

The TDS range at Station 41 (Figure 24) is 200 to 1400mg/litre, the daily flow about 17Ml and the daily load 12 tonnes, the equivalent "domestic" load is 5,1 tonnes. Station number 38 (Mossops Tannery) with a flow of 0,4Ml daily contributes a mineral load of 4,2 tonnes daily, and number 40 (Ohlssons Brewery) has a flow of 1,5Ml and a daily TDS load of 0,8 tonnes.

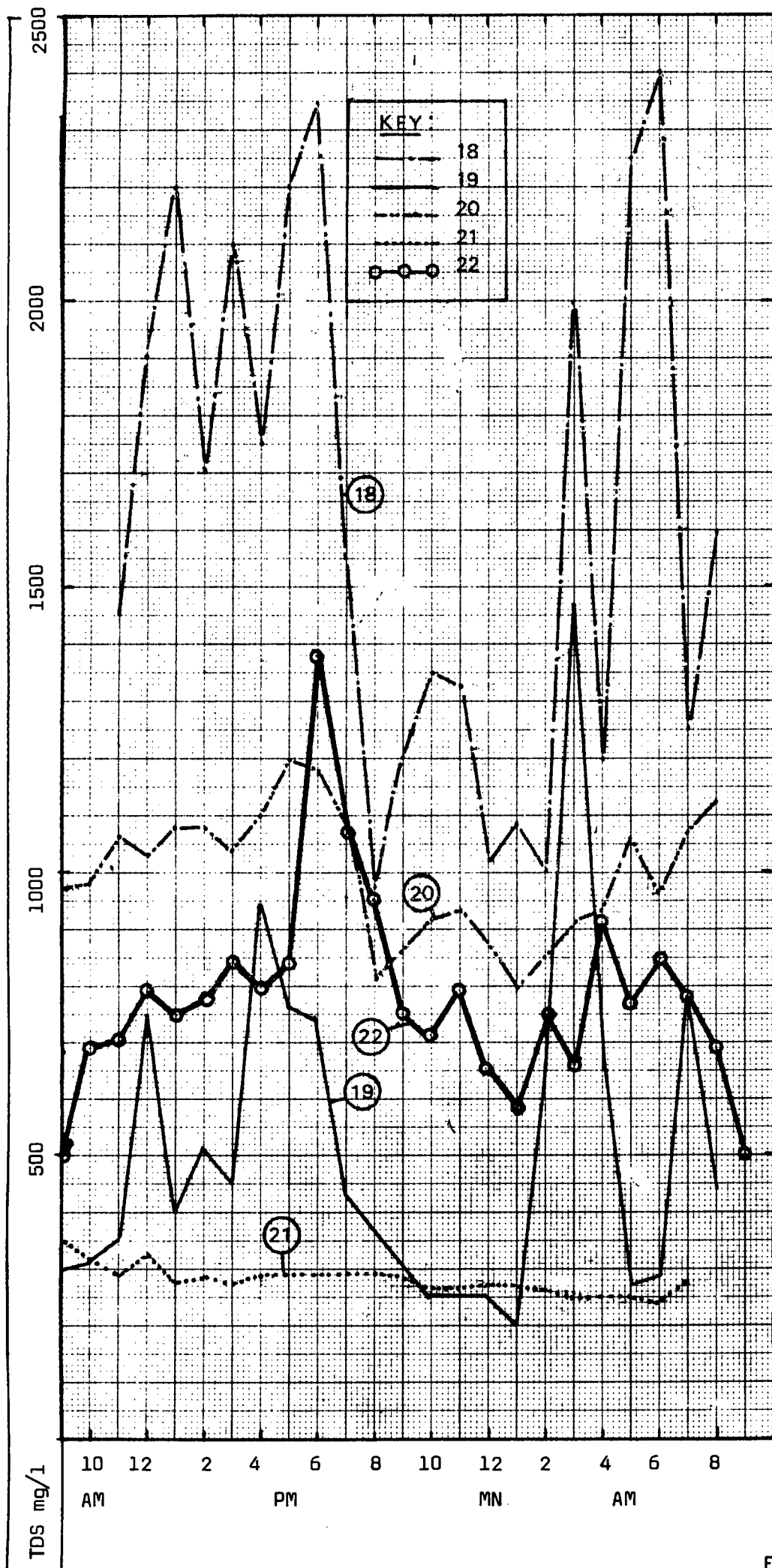
It is clear that these two sources contribute a large proportion of the total mineral load from this system.

(ii) The Mowbray - Woodstock System.

Sampling Stations are numbers 42, 43 and 44 (Figure 17)

STATION 44 is mainly domestic and needs no further comment. STATION 42 is domestic and industrial but as no flow data is available the impact of this area cannot as yet be estimated.

STATION 43 which includes the discharges from numbers 42 and 44, has a TDS range from 450 to 800mg/litre, a daily flow of about 14Ml, and a TDS load of 9 tonnes. With an equivalent domestic load of 42 tonnes, it is apparent that nearly 5 tonnes daily must be accounted for. While there may be infiltration in the three low-lying areas, served by sub-pumping stations, the probability of this being



THE EFFECTS OF TDS MIXING:  
 STATION 18 + STATION 19 = STATION 20 = MIXED INDUSTRIAL AND DOMESTIC  
 STATION 20 + STATION 21 = STATION 22  
 (domestic)

FIGURE 25.

the entire source is remote. The conclusion is that industry is the main TDS contribution.

This system then joins the Liesbæk System below Station 41, and the TDS range is shown under Station 19 on Figure 15 and 25; no flows are available but by summation of 41 and 43 the flow is estimated at 31Ml and the mineral load 21 tonnes and the "domestic" load 9 tonnes i.e. 12 tonnes must be from industry; of this nearly 5 tonnes come from the two industries in the Liesbæk System (Stations 38 and 40).

(iii) The Black River System.

The only sampling station on this system is number 21 which indicates a residential area of having a range of TDS from 240 to 350, the latter occurring at 9.00 a.m., as is typical in such areas. With a flow of 8Ml the TDS load is 3 tonnes which is normal.

This station is included in Figures 15 and 25.

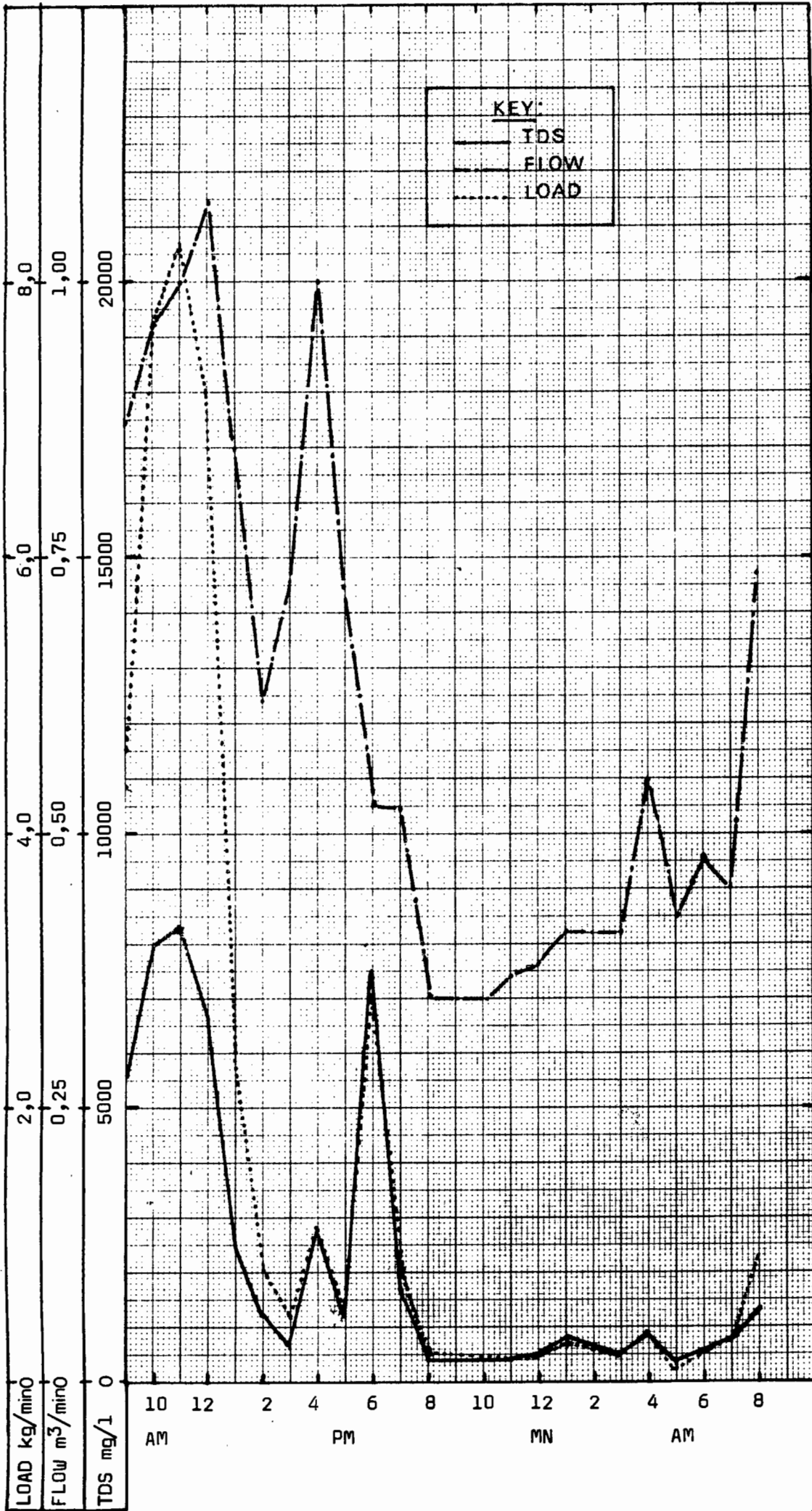
(iv) The Maitland System.

Sampling Stations 18, 23 to 27, 34, 47 to 48 were established for this system.

(a) PAARDEN EILAND.

Dealing first with the Paarden Eiland area (Stations 25 to 28) consider Station 26 (Carlisle Street Pumping Station). This pumping station serves the entire area and discharges into the Upper Camp Street sewer above Station 23.

The Paarden Eiland Industrial Township comprises a reclaimed area which was previously the delta of the Salt and Diep Rivers. The ground levels are  $\pm 2$  metres MSL, i.e. only a little more than one metre above high tide level. Most of the sewers are, therefore, at or below a perennial water table; they were constructed under probably the most difficult working conditions encountered in the Cape Peninsula.



STATION 28: INDUSTRIAL EFFLUENT. TDS DROPPING AT NIGHT TO 500 mg/l.

FIGURE 26.

Considering that the major portion of the Township was developed about 1938, with extensions in the immediate post war period, a fairly high infiltration rate would be expected. As the ground waters are equivalent to sea water it is surprising that night time salinities - when industry is normally inactive - are so low.

STATION 27 shows a TDS range of 65 to 140mg/litre indicating no infiltration and a low night TDS, probably from the sources similar to Station 49 (See Figures 17 and 20).

STATION 28 - Auckland Street - on which exists the leak shown in Figure 4, drops to a TDS of 300mg/litre at night and peaks to 8300 during the day as shown on Figure 26. The night flows are as low as 0,35 m<sup>3</sup>/minute which indicates that the flow must be nearly all mains water if infiltration (35000mg/l) is diluted to the TDS concentrations measured. The diurnal data is illustrated in Figure 26.

STATION 26, Carlisle Street, shows widely fluctuating TDS concentrations, ranging from 800 to 12000 and is clearly indicative of waves of saline discharges from industry; these waves occur throughout the 24 hours of the day.

STATION 28 reflects this position and the range of TDS is from 1900 to 6300mg/litre; the flow at this Station is about 0,8Ml and the TDS load about 2 tonnes which is very high.

The Paarden Eiland Industrial Township contributes some 1,5Ml of effluent daily with a corresponding load of 6,0 tonnes; this is excessive and examination of the system and enforcement of the Regulations must be pursued.

(b) RUGBY, BROOKLYN AND TIJGERHOF.

Sampling has been confined to Stations 47 and 48 in Rugby. This area is primarily residential but has some light industry.

The TDS range is from 320 to 670mg/litre at Station 48, and

from 410 to 910 at Station 47.

STATION 48 shows higher salinities by day, except during the morning peak and a drop at night with low flows.

The groundwater TDS measured was 420mg/litre and the pattern is suggestive of infiltration with waves of a moderate TDS from industry.

STATION 47 clearly shows the typical pattern of infiltration.

(c) MAITLAND (INCLUDING PORTIONS OF THE NDABENI INDUSTRIAL TOWNSHIP) AND KENSINGTON (RESIDENTIAL)

STATIONS 24 and 34 are representative of the area which continues with Paarden Eiland, Rugby and Brooklyn at Station 23; the entry of the Ndabeni Industry Township and the Abattoir is reflected at Station No. 18 (See Figure 25).

STATION 34 (Kensington residential) shows higher than normal TDS concentrations, ranging from 540mg/litre by day to nearly 900 at night; this area demonstrates infiltration.

STATION 24 (Maitland) shows higher than normal TDS concentration ranging from 500mg/litre at night to 760mg/litre by day. This is mainly a light industrial area and the pattern is typical of low salinity flows from this source.

STATION 23 has a TDS range from 800 to 4700 the latter occurring at night with low flows.

The contributions to this sewer represent a load of 10 tonnes daily with a flow of about 5Ml.

STATION 18 (Figure 25) is representative of the combined flows from the preceding sections of the system and shows a TDS range from 1000 to 2400mg/litre. Two sets of peaks occur here, from 11.00 a.m. to 6.00p.m. and from 2.00 a.m. to 7.00 a.m.

There is no doubt that the mineral load here is mainly from industrial areas with some infiltration.

As no flow data is available, the flow at Station 18 has been estimated at 6Ml and a load of about 12 tonnes; the increase over Station 23 is due to the abattoir and industry in Ndabeni West which are known to be high contributors of mineral loads; the equivalent "domestic" load is 1,8 tonnes.

(v) The Raapenberg Pumping Station

The flow from the above four systems is combined at Raapenberg.

STATION 20 indicates the combined flows from Systems 1, 2 and 4; STATION 22 (the Pumping Station itself) reflects the flows from all four systems i.e. Station 21 added to Station 20.

Figure 25 shows quite dramatically how Station 19 (Systems 1 and 2) and Station 18 (system 4) give the results at Station 20 and how Stations 20 and 21 (System 3) combine to give number 22.

The results at Station 22 clearly demonstrate the dilution of industrial loadings by high quality flows from residential areas.

The daily loads and flows are summarised as follows:

TABLE 7

<u>Sampling Station</u>	<u>Daily Flow - Ml</u>	<u>Mineral Load - Tonnes</u>		
		<u>Actual</u>	<u>Equivalent Domestic</u>	<u>Difference</u>
41	17	12	5,1	6,9
43	14	9	4,2	7,8
18	6	12	1,8	10,2
21	8	3	2,4	0,6
22	45	36	13,5	22,5

System 4 (Station 21) does not require any specific investigation as no abnormalities appear to exist.

System 1 (Station 41) has the two major industries which are responsible for nearly 5 tonnes per day.

Further investigations are necessary in Sections 2 and 3 - i.e. the Woodstock and the Maitland Systems - to track down the main sources of industrial load.

(e) THE CATCHMENT OF THE BOKMAKIERIE PUMPING STATION.

This catchment is represented by STATION 52.

The TDS concentrations range from 380 to 480mg/litre and are probably accounted for by socio-economic conditions.

The catchment of this station contributes about 2Ml and a mineral load of 0,8 tonnes which can hardly be called abnormal.

Chapter 13:            THE MINERAL LOAD AT THE ATHLONE  
SEWAGE TREATMENT WORKS.

With a daily dry weather flow of some 90 - 100Ml, the total daily load is in the vicinity of 80 tonnes.

The sampling of the catchment system confirms the total load as about 76 tonnes. It will be realised that the sampling was undertaken over an extended period and that the contributions from each area are not strictly additive.

However, accepting the total load as 76 tonnes comparisons of contributions from the three catchments are shown in Table 8.

From this it will be seen that the Langa Main Catchment contributes slightly more than half the total mineral load and System 2 (Goodwood/Parow) supplies 27,7% of the total excess over "domestic" load. The next two greatest contributors are Systems 1 and 3 of the Raapenberg Catchment and the latter - mainly industrial - contributes the highest load per Ml of daily flow.

This confirms that industry is the greater contributor of mineral load in the Athlone Treatment Works Catchment, but System 4 of the Langa Main Catchment - Pinelands and Ndabeni - contributes the highest loading in tonnes/Ml. As indicated previously, this arises from infiltration in Pinelands.

A very conservative estimate would give a mineral load from infiltration of 10%, say 8 tonnes daily.

The load from industry would then account for the balance over the equivalent domestic load, viz. tonnes.

To summarise, the position in the Athlone Sewage Treatment Works catchment is approximately as follows:

Mineral Load from Domestic use:	30 tonnes/day
Mineral Load from Infiltration:	8 tonnes/day
Mineral Load from Industry:	<u>38</u> tonnes/day
	<u>76</u> tonnes/day

TABLE 8

Catchment	Daily Flow Ml	Mineral Load				
		Actual	Domestic	Difference	% of total	tonnes per Ml
Langa Main. System 1	5	4,0	1,6	2,4	5,1	0,60
"    2	28,5	21,5	8,5	13,0	27,7	0,47
"    3	4	3,5	1,2	2,4	5,1	0,6
"    4	5	6,0	1,5	4,5	9,6	0,9
"    5	<u>9</u>	<u>4,0</u>	<u>1,6</u>	<u>2,4</u>	<u>5,1</u>	<u>0,27</u>
	51	39,0	15,5	24,7	52,6	0,46
Raapenberg. System 1	17	12	4,7	7,3	15,3	0,43
"    2	14	9	3,5	5,5	11,8	0,39
"    3	6	12	4,7	7,3	15,3	1,22
"    4	<u>8</u>	<u>3</u>	<u>1,2</u>	<u>1,8</u>	<u>3,9</u>	<u>0,22</u>
	45	36,0	14,1	21,9	41,7	0,49
Bokmakierie	2	1	0,6	0,4	0,9	0,45
	98	76	30,2	47,0	99,8	

Chapter 14:            GENERAL OBSERVATIONS AND CONCLUSIONS.

1.            The investigation into the catchment of the Athlone Sewage Treatment Works can be regarded as only of a preliminary nature. Much detailed investigation must still be carried out to track down specific sources of mineral pollution..
2.            The high concentrations of dissolved inorganic solids in the final effluent, which vary approximately between 800 and 900mg/litre, render the effluent of little use.
3.            The present use of effluent for (1) cooling water 10Ml/day to the Athlone Power Station, and (2) irrigation of salt resistant vegetation in sandy soils, where there is no build-up of salts, are for all practical purposes the only markets for such effluent.
4.            The high TDS renders the effluent unsuitable for industry, irrigation (high chlorides) and for reclamation to potable standards.
5.            No appreciable beneficial use could be made of the present effluent for reduction of the demand for fresh water unless the TDS concentrations are drastically reduced.
6.            Reduction of the TDS to below 500mg/litre (i.e. the upper limit for potable waters) would render the effluent suitable for reclamation to potable standards and for recharging of the aquifer on the Cape Flats currently being investigated by the National Institute for Water Research. <sup>(18)</sup>

For comparison it should be noted that the average TDS in the maturation ponds of the Windhoek Sewage Treatment Works <sup>(19)</sup> which deals only with sewage from domestic areas, is 740mg/litre. This concentration arises from a mixture of treated surface (dam) water 186mg/litre) and water from boreholes (498mg/litre) with a resulting TDS of 375 i.e. the TDS uptake is 365mg/litre. After reclamation of

of the maturation pond effluent and its subsequent integration with the above sources the TDS in the mains is 475mg/litre; without the use of borehole water the TDS would be even lower. The chlorides range from 11mg/litre for borehole water to 26mg/litre for raw dam water - 163mg/litre for maturation pond water before reclamation.

7. A reduction of TDS on the above lines if accompanied by reduction of chlorides would also render the effluent more suitable for agricultural use.

8. In this form it would be feasible to pump the effluent into the Berg River between the Wemmershoek Dam and so release the compensation waters (55Ml/day over six months) for potable supplies.

9. The present state of development of desalination processes does not enable one to foresee the desalination of the large quantities of effluent currently available (180Ml daily from both the Athlone and the Cape Flats Treatment Plants), nor would it be possible to deal effectively with the increases in effluent volumes which will follow full development in the contributing areas and development of housing on Mitchell's Plain.

10. The yield of fresh water from resources presently available together with schemes to be developed by the State under the Boland Water Scheme is likely to be exceeded before the turn of the century.

11. Greater attention must, therefore, be given to the re-use of sewage effluent.

12. The recharging of the aquifer system (6 above), and the subsequent withdrawal of ground water for integration with the mains supplies, would appear to be the most promising wholesale use of effluent.

13. This method of re-use must be coupled with the reduction of mineral salts in the effluent.

14. The reduction of mineral load must be attained by one or more of the following methods:

(a) Sealing of all major leaks into the sewerage system.

Here closed-circuit television must be used to detect all leaks and the most effective method of repair must be employed. Video-tape recordings of such surveys are of inestimable value for enabling management in local authorities to evaluate the best methods: currently available methods in descending order of cost are:

- (1) reconstruction: at the current costs of excavation in urban areas with difficult traffic conditions this method is the most expensive;
- (2) sleeving: this method used in Welkom, O.F.S., and shortly to be used in Cape Town to repair the sewer shown in Figure 7, would appear to be the most economic for concrete sewers where only the soffit has failed or for deep sewers of any kind; the main difficulties are diversion of the flow, the ramps for entry and any bore irregularities as would stop the sleeving process;
- (3) grouting: the three methods available in the United States are: (a) internal injection of grout and catalyst by special equipment into each defective joint, the defect being simultaneously positioned by the television camera; (b) internal flooding of sewer by grout and catalyst to the depth necessary to balance external water pressure (the "Infilcheck" process) and (c) external injection of grout and catalyst through a well point sunk to the defect (the "Infiljet" process) - this method holds great promise in areas of high water table and is to be used shortly by a contractor to seal leaks in a sewer which has developed defects during the maintenance period of the construction. This would however, only account for about 10% of the total daily mineral load.

(b) Restriction of TDS loads which may be discharged.

The results so far of the initial survey to enforce the City Council's Industrial Effluent Regulations show very widespread discharges of saline effluents. There is no doubt that industry must be forced to comply with a reduction of TDS loads. It must be understood that more efficient use of water by an industry inevitably leads to raising the TDS load: recycling of water, evaporative cooling towers, etc. all lead to a concentration of salts. Air conditioning for example, if done in conjunction with evaporative cooling towers, concentrates the very low mineral content of Cape Town water very considerably. To quote two examples: (i) bleed off: a 50% evaporation in one building leads to a TDS concentration of 1200mg/litre and an outflow of 14kl per day i.e. a mineral load of 17kg/day; (ii) "closed circuit" with ion-exchange water treatment: 1,4kl per day and a load of 21kg per day. In both cases the chlorides constitute about half the load, and neither effluent complies with the General Standards for Industrial Effluents and cannot, therefore, be discharged into municipal stormwater drains which lead to watercourses.

It would seem reasonable to forbid such discharges to the sewers unless the mineral salts were removed on site.

This method would probably be the easiest under the present day desalination technology but would introduce a further difficulty - the disposal of concentrated untractable effluents (e.g. brines) from many different premises.

However, the use of water for air conditioning in Cape Town does not provide a major problem at the present time, but the author is concerned about the increase in mineralised discharges as the use of air-conditioning with evaporative cooling systems is extended.

Even air-conditioning consultants do not fully realise the implications arising from the mineralised discharges and the author deals with each case in a searching approach: apparently the daily purging of a water treatment plant with a TDS concentration of 15000mg/litre is not regarded as a contravention of Regulation No. 6 (See Table 2).

As it is not expedient to withhold approval of plans for modern buildings where internal office accommodation cannot be provided without artificial ventilation, the author has adopted an interim approach and issues the Written Consent (Table 2, Appendix 2D) with a special condition requiring review of the approval after twelve months.

While the problem of disposal of intractable effluents will arise in any major scheme for desalination, it could be more easily solved by individual disposal. What is needed is a special waste disposal service and special depositing sites. This problem can be solved only on a national scale as an overall policy is needed to allocate disposal sites from which there will be no further pollution; in some cases commercial use could be made of concentrated salts. The problem is somewhat akin to the disposal of radio-active wastes.

It is possible that an ion-exchange process could be developed to convert the major mineral load in sewage effluent to beneficial salts, such as nitrates and phosphates before discharge to agriculture.

In addition to any reduction in the present legal TDS concentration of 2000mg/litre, it may be necessary to force industry to bear a greater financial share of the results of its high TDS contribution.

Consideration will have to be given to the introduction of a TDS factor in the Industrial Effluent Charging Formula in Regulation 4

of the Cape Town, Goodwood and Parow Drainage and Sewerage Regulations so as to penalise industry for failure to comply with restrictions and thus leave the community as a whole with unusable effluents.

(c) Separation of high from low salinity wastes.

If economically feasible, this method would enable use to be made of the low salinity effluents in the recharging of the proposed aquifer system (6 and 12 above).

The separation was suggested by the National Institute for Water Research<sup>(10)</sup> and is the basis of the California proposals.<sup>(5),(6)</sup> While industrial areas are well defined under modern town planning schemes, these very areas are mainly contiguous to labour reservoirs and the effluents are inevitably mixed.

Provided the cost could be faced, the following changes could be made in the Cape Town System: (i) diversion of the mainly domestic sewage from the Green Point (Sea) Outfall to Athlone; (ii) diversion of Baarden Eiland, Maitland and Kensington sewage to a special treatment plant for high salinity wastes, to the north of Milnerton; (iii) the separation of Parow and Goodwood Industrial Areas possible to the same works.

Diversions of this nature would be very costly, but the feasibility of the proposals, including the establishment north of Milnerton of a special treatment plant with a sea outfall, should be investigated. In the author's opinion this suggestion is technically possible but a decision can be reached only after an overall cost/benefit analysis has been made.

Before any overall finality is reached, the survey of the catchment of the Wynberg and Cape Flats Treatment Works (now in progress) must be completed.

Analytical Data<sup>(7)</sup> shows the average TDS to be of the order of 900mg/litre (about the same as at Athlone) with chlorides in excess of 280mg/litre.

15. STANDARDS OF MATERIALS AND METHODS OF CONSTRUCTION.

The advent of the flexible joint in sewer pipes was hailed as the solution to all problems arising from rigidly-jointed sewer pipes.

It is the author's opinion arising from a review of works with which he has been associated in Cape Town over the past twenty five years, that the flexible joint for vitrified clay pipes leaves much to be desired.

This opinion arises not from the concept of the joint itself but from the fact that pipe manufacturing tolerances are too high; this aspect was raised in Chapter 9. Unless a rubber ring in a joint is uniformly compressed inward leakage will result.

To bear this out, it is interesting to note that little trouble has been experienced with spun concrete pipes having rubber ring joints primarily for the reason that manufacturing tolerances are high - post constructional leaks arise solely from external causes such as the settlement recorded in Chapter 9 and illustrated in Figure 9.

When constructing sewers in water logged subsoil - the normal situation on the Cape Flats - a bed of stone is normally laid preparatory to casting the bedding slab for the sewer or prior to bedding the sewer itself.

The purpose of the stone bed is to provide a working surface but it is NOT intended to act as a french drain; drainage trenches are provided on either side of the bed to keep the working area dry.

Very close supervision must be exercised to ensure that construction staff do not use the bed to drain the excavations: to do so is to invite differential settlement once the interstices begin to fill. The Paarden Eiland sewers were laid under the most stringent supervision and the very low infiltration today bears testimony to the high standards of construction.

With rigid joints, the pipes themselves will bridge local subsidences but the pipes may then fail; there is, however, not much evidence of this type of failure in the many sewers examined by closed-circuit television.

Because of the trouble experienced with rubber ring joints in vitrified clay pipes, and even with the newer polyurethane joints there is a growing tendency to use other types of pipe.

The dolomitic aggregate spun concrete pipes used in Cape Town for all sewers over 450mm diameter, since 1958 (apart from a brief experiment with internally lined pipes) are probably the best solution to the problem of sulphation evolved in South Africa; the replacement of siliceous by calcareous aggregate was a recommendation of the National Building Research Advisory Committee of the South African Council for Scientific and Industrial Research. (20)

There is no real reason why their use should not be extended to the smaller sizes; in fact this has been done, but vitrified clay pipes have given exceptionally good service (since 1897 in Cape Town) and there is a reluctance to abandon their use, particularly when resistance to sulphation is considered.

However, asbestos-cement pipes appear to offer the same resistance to sulphation as dolomitic aggregate pipes; these pipes with vastly superior rubber ring joints, are now being used in waterlogged areas.

There is no doubt that standards of construction using conventional materials have dropped in the post-war years; it is probable that a great deal of the infiltration now occurring stems from this cause and not from the pipes themselves. However, the superior claims made for respect of flexible joints appear to have introduced an aura of complacency with a consequent reduction of standards.

This raises the issue of the newer materials. The very rigidity of vitrified clay and spun concrete pipes has been regarded as the ideal requirement for sewer pipes. The era of plastics has heralded new concepts, but the flexible nature of these materials does not meet the approval of the conservative engineer; to this must be added doubts as to resistance to abrasion, not only from the substances transported by the pipes but from normal cleaning equipment.

However, PVC pipes are now permitted for private sewers and the newer high density polyethylene holds out promise of a durable material with freedom from joint problems. This material lends itself ideally to lining of defective "rigid" sewers whether they be of spun concrete or vitrified clay and is to be used in the repair of the defective sewers shown in Figure 7. It may well prove to be the ideal pipe for normal use, and pressure-jet cleaning equipment (already in use) may displace the dragged bucket.

To conclude this thesis, the author wishes to emphasise that in the conservation of our water resources, it is quite clear that the pipe manufacturing as well as both the civil engineering design and construction industries must revise their respective outlooks to ensure that infiltration of saline ground water does not become an even greater factor in our present inability to re-use effluents from the Athlone Catchment of the Cape Town Sewerage System.

REFERENCES:

1. Republic of South Africa: Act No. 54 of 1956, with subsequent amendments.
2. Ibid, Section 1(xxi).
3. Republic of South Africa: "Regional Standards for Industrial Effluents"  
(Government Notice R553 dated 5th April, 1962).
4. Morris, R.D. "A Survey of South Africa's Natural Waters"  
(Institution of Water Pollution Control: Conference Johannesburg and Pretoria, May 1972).
5. The Resources Agency of the State of California, U.S.A. "Feasibility of Reclamation of Water from wastes in the Los Angeles Metropolitan Area".  
(Department of Water Resources, Bulletin No. 80, December, 1961)
6. Parkhurst J.D., Carry C.W., Masse H.N., English J.N. "Practical Applications for Re-use of Waste Water"  
(Chemical Engineering Progress, Symposium Series, Vol.64, No.90, 1968).
7. City of Cape Town: "Annual Report of the City Engineer for the year ended 31st December, 1970".
8. McKee J.E., and Wolf H.N. "Water Quality Criteria", 2nd Edition 1963. (State Water Quality Publication Board, Publication No. 3 - A, The Resources Agency of the State of California.)
9. National Institute for Water Research: Project No. 802, Reports 7, 8, 9 & 14.
10. Ibid: Report No. 11.
11. S.A. Council for Scientific and Industrial Research: Technical Note No. X/BOU 107 Building Series DIS 107, July, 1966.
12. Crimp & Bruges: "Table and Diagrams for use in Designing Sewers and Water Mains".  
Metric Edition 1969. Municipal Publications Co. Ltd, London WC 2.
13. Republic of South Africa: "Regional Standards for Industrial Effluents - Methods of Testing"  
(Government Notice R3208, dated 29th August, 1969).

14. S.A. Council for Scientific and Industrial Research: "Technical Information for Industry" Vo. 4., No. 12, pp 1-4, Pretoria 1966).
15. Ordinances of the Province of the Cape of Good Hope: "Municipal Ordinance No. 19 of 1951, with amendments."
16. Announcement by Minister for Water Affairs, 22nd September, 1971.
17. Hutson, J.L.: "Use of Second-grade water for supplementing irrigation in the Pretoria - Witwatersrand - Vaal Triangle Area" (The Civil Engineer in South Africa, Vol. 14, No. 8, pp 269 - 272, August, 1972.
18. National Institute for Water Research: "Projek 814: Opberging van water in Natuurlike Sandbeddings: Verslag No. 16, 1971."
19. Van Vuuren L.R.J., Henzen M.R., Stander G.J. and Clayton A.J.: "The Full-Scale Reclamation of Purified Sewage Effluent for the Augmentation of the Domestic Supplies of the City of Windhoek" (Proceedings of the 5th International Water Pollution Research Conference July-August, 1970. Published by Pergamon Press Ltd, 1971).
20. S.A. Council for Scientific and Industrial Research: "Corrosion of Concrete Sewers". CSIR Series DR 12, Pretoria 1958.

# KEY PLAN TO SALINITY SAMPLING STATIONS.

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