A WATER QUALITY MANAGEMENT SIMULATION GAME

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PREFACE

This paper is a description of a simulation game applied to Transferable Discharge Permits (TDP's). It uses a participant program to input data, a proctor program to simulate seasonal conditions, a cost program to evaluate the economic effectiveness of the TDP's, and the QL2SMG package to measure the impact on water quality.

I would like to express sincere gratitude to my major advisor Dr. Richard N. Devries, for his guidance and motivation. I am also thankful to Dr. Keith D. Willett and Dr. Ramesh Sharda for their insightful suggestions and invaluable help during the course of this work. An extra thank you must go to Dr. Vernon A. Mast and Dr. Enos L. Stover for agreeing to serve on my committee.

My deepest gratitude to my parents for their encouragement and for their love.

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CHAPTER I

INTRODUCTION

In recent years, environmental policy has become an increasingly important part of government regulatory activities. This, in turn, has motivated questions addressing the effectiveness of these activities. In particular, these questions are concerned with the cost effectiveness of regulatory activities as well as the ability to bring waste dischargers into compliance with environmental quality standards. An important concern is to evaluate the use of Transferable Discharge Permits (TDP's) in the attainment of water quality objectives.

A number of methods are available that could be used to evaluate the effectiveness of TDP's. David et al. [1] and Eheart et al. [2], for example, have used mathematical programming methods to evaluate the effectiveness of TDP's. In assessing the use of mathematical programming models, perhaps it could be argued that behavior cannot be predicted in a deterministic way. That is, optimization models presuppose some form of rational behavior on the part of managers such as profit maximization or cost minimization.

A viable alternative to mathematical programming models for addressing the effectiveness of TDP's is simulation gaming. The simulation game can be helpful for examining theories involving simplified situations and for abstracting phenomena from the real world. Simulation gaming has been employed as a tool for researching

and for training in various fields. However, it is a new issue to Water Quality Management (WQM) decisions. Simulation gaming is valuable not only for teaching aspects of water quality decisions, but it can also be used as a research tool in understanding economic issues of water quality management.

The objective of this dissertation is to develop a water quality management simulation game to be used in exploring the effectiveness of achieving water quality standards with a system of transferable discharge permits. The potential for substantial cost savings from trading TDP's is demonstrated using data on a hypothetical river. The game will be tested initially without offering a TDP as an alternative. After four periods the game will include TDP's as an option for water quality decisions. A simulation model of water quality (QL2SMG) is used to study the impact of waste loads (magnitude, quality and location) on in-stream water quality. QL2SMG permits simulation of oxygen dynamics in a one-dimensional system with steady state hydraulics. Details of QL2SMG are given in Chapter III.

CHAPTER II

BACKGROUND AND LITERATURE REVIEW

An Overview of TDP's

Transferable Discharge Permits (TDP's) have been examined over the past 20 years as a policy to achieve any desired level of air or water pollution abatement [3, 4, 5, 6]. Under this policy, the agency considers the assimilative capacity of the environment and issues the permit. Once distributed, the permits are tradable among polluters, their price being set by market forces and the cost of alternatives to pollution. Of course, no polluter may discharge the pollutant in excess of permit holdings, and enforcement is effected by the provision of fines which exceed the market value of the effluent permits.

The TDP system is called an "incentive type" system. The trading of permits allows more efficient waste processors to operate at a high removal efficiency and hold relatively few shares of effluent permits, while allowing less efficient waste processors to hold a relatively large number of permits, and perform little or no waste removal.

TDP's offer dischargers the alternative of purchasing a substitute for abatement. Entering the market is not coercive and will only be done when it appears profitable. In the short run, permits can be purchased to cover the excess discharges associated with plant failure or production overruns. On a seasonal basis, TDP's can be purchased to cover deficient capacity during a period of exceptionally limited

assimilative capacity in the river. On a long-term basis, TDP's may be used to provide for a substantial part of abatement during periods where one firm is deficient in abatement capacity while another has excess capacity [7, 8, 9, 10].

Economic Rationale for TDP's

The rationale for using TDP's as a policy approach for achieving water quality objectives can be examined by using a command and control approach to allocate the responsibility for meeting a specified water quality level standard [11].

An example for two wastewater discharges is shown in Figure 1. The amount of wastewater discharged for A and B is shown on the horizontal axis and is read from left to right. The amount of pollution abatement undertaken is essentially the same as reducing the total level of discharge and is represented by reading from right to left. The cost of undertaking pollution abatement is represented by marginal control cost curves MC_A and MC_B . Marginal control costs are assumed to increase with an increase in the amount of pollution abatement. Prior to any regulatory action by the environmental authority, A will discharge $O\overline{E}_A$ and B will discharge $O\overline{E}_B$.

Now suppose that the environmental authority sets a discharge standard of E_{T1} so that the total discharge from both dischargers cannot exceed E_{T1} (i.e., $0E_A + 0E_B \leq 0E_{T1}$). It is also decided that each discharger will be required to reduce discharge by an equal amount when allocating the responsibility for complying with the standard. Thus discharger A will be required to reduce its discharge by $E_{A1}\overline{E}_A$ and discharger B will be required to reduce its discharge by $E_{B1}\overline{E}_{B}$. The

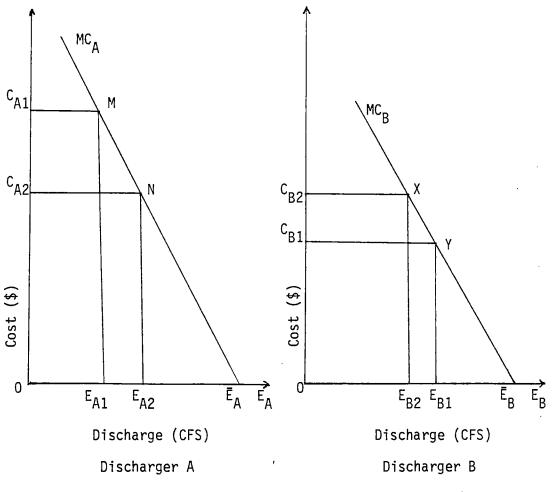


Figure 1. Command and Control Regulatory Approach

total control cost for discharger A is equal to the geometric area $E_{A1}^{ME}A$ and the total control cost for discharger B is equal to the geometric area $E_{B1}^{YE}YE_B$ on Figure 1. Total costs for complying with the standard are the control costs for the two dischargers.

It can be noted from Figure 1 that the marginal cost of reducing discharge by $E_{A1}\bar{E}_A$ for discharger A is C_{A1} while the marginal cost of

reducing discharge by $E_{B1}\bar{E}_{B}$ for discharger B is C_{B1} . This implies that total control costs can be reduced if discharger A is able to reduce the amount of its pollution abatement (i.e., increase its level of discharge) while discharger B is to increase its amount of pollution abatement (i.e., decrease its level of discharge). This is true because the reduction in total control cost for A to increase its emissions discharge, represented by the various points on its marginal cost curve as MC_A , is greater than the marginal cost or increased total control cost incurred by B for a higher level of pollution abatement. It is no longer possible for total costs to be reduced once marginal control costs for all dischargers are equal. In terms of Figure 1, this occurs when discharger A undertakes abatement equal to $E_{A2}\bar{E}_A$ units of discharge and discharger B undertakes abatement equal to $E_{B2}\tilde{E}_{B}$ units of discharge. Of course, marginal control costs are equal at this point (i.e., $C_{A2} = C_{B2}$). Thus, the cost of achieving a given water quality standard will be minimized if and only if the marginal costs of control are equalized for all dischargers.

The rationale underlying the preference for TDP's as a regulatory mechanism for achieving a cost-minimizing solution for complying with a given water quality standard can be demonstrated with the aid of Figure 2. Assume that the environmental authority sets a standard for discharge of OE_{T1} and creates the same number of TDP's. The supply of TDP's is predetermined since the total amount is controlled by the environmental authority. Thus, the supply of TDP's is given by \overline{S} . Assume also that the individual marginal control cost curves MC_A and MC_B can be horizontally aggregated into a total marginal cost curve

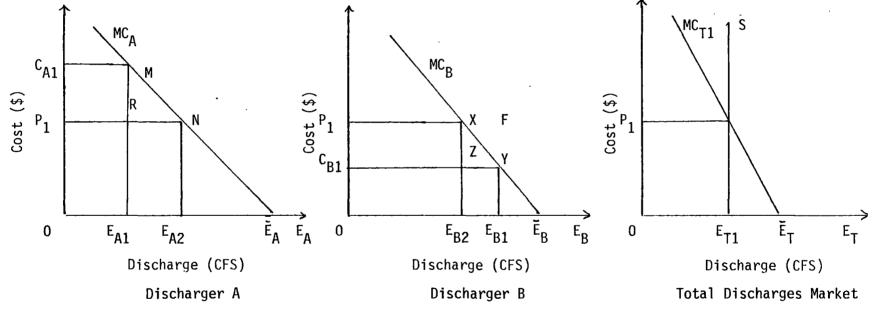


Figure 2. Transferable Discharge Permit Market

Assume that the environmental authority makes an initial distribution of TDP's to the two dischargers as follows: discharger A receives OE_{A1} permits and discharger B receives OE_{B1} permits (Note that $OE_{A1} + OE_{B1} = OE_{T1}$). Dischargers are then allowed to buy and sell permits in a single clearing price TDP market. The decision to buy or sell permits will depend on the price of permits relative to the marginal cost of pollution abatement. Thus MC_A and MC_B are the individual dischargers demand curves for TDP's and MC_{T1} is the total market demand curve for TDP's.

The market-clearing price in Figure 2 is given by P_1 . Discharger A will then demand OE_{A2} permits and discharger B OE_{B2} permits (where $OE_{A2} + OE_{B2} = OE_{T1}$). In terms of their initial allocations, discharger B will sell discharger A a number of permits equal to $E_{A1}E_{A2} = E_{B1}E_{B2}$ at a price of P_1 per permit. Discharger A will now incur an abatement cost of $E_{A2} \ NE_A$ for abating emissions equal to $E_{A2}E_A$, and will spend an amount equal to $E_{A1}RNE_{A2}$ for a number of TDP's equal to $E_{A1}E_{A2}$. Discharger B, on the other hand, will increase its level of emissions abatement by $E_{B2}E_{B1}$. B will also realize an increase in its abatement cost equal to $E_{B2}XYE_{B1}$, but receives TDP revenue equal to $E_{B2}XFE_{B1}$. Discharger A is then subsidizing part of B's treatment cost plus providing B with a net profit equal to XFY.

This has two desirable effects. The first is that each discharger has a continuing incentive to seek further ways to reduce discharges. The second is that the market assumes that the marginal costs of the waste control are the same for different dischargers. If the costs to each discharger for eliminating the last unit of wastes are the same,

then there are no opportunities to achieve the same total discharge reductions at a lower total cost.

Benefits of TDP's

The TDP system has four desirable attributes. These are simplified regulation, saving in treatment costs, incentive and flexibility, and the ability to deal with the gorwth and entry of dischargers.

<u>Regulation</u>. Regulation is reduced. For example, effluent charge control for a river basin can be made simple and inexpensive with the TDP system. In addition, when permits expire, the regulatory authority can reduce the total amount of permits by issuing fewer. More important, the regulatory authority has the opportunity to buy permits on the open market and to retire them. Neither of these procedures is excessively complicated administratively and can be accomplished without devising different rules and procedures for different polluters.

<u>Treatment Cost Saving</u>. The reduction in treatment costs under TDP's occurs because under a TDP system the most technically efficient treatment plants will remove more of the pollution load. Braasch and Joeres [12] estimated that TDP's would result in a cost saving for the Lake Michigan basin of Wisconsin of three quarters of a million dollars annually. This cost reduction will occur without violating the wastewater level standard.

<u>Incentive and Flexibility</u>. For the dischargers, the important incentive is that TDP's allow flexibility in operation. Industries can

then more readily vary production and operate closer to the margin without always having to consider long-range capital investment planning. While it is hard to value flexibility in dollars, flexibility can be stressed as an advantage.

Municipalities can gain from improved timing of construction of wastewater treatment plants. Delays in construction can be handled with the purchase of permits, rather than requests for variances. And any delays in construction may allow refinement of population service demand projections. This creates potential for improved plant designs.

Incentive for the regulator derives from the fact that TDP's support the environmental mission of the agency. TDP's enhance the likelihood of meeting environmental goals. Requiring dischargers to fully explore TDP's prior to requesting variances will reduce the number of such requests to the agency, thus reducing the need for difficult social welfare decisions.

<u>Growth and Change</u>. The growth and entry of polluters are handled naturally and efficiently in the TDP system. Increasing waste discharges, through either entry or growth, is allowed only upon the acquisition of effluent permits. Thus, new entrants will increase the price of TDP's. This is an advantage to holders of rights who elect to sell. The increased demand for a fixed supply is a disadvantage for dischargers wanting to increase their discharge. The TDP system is preferable for all dischargers. Because although the unit cost of treatment rises as increasing amounts of pollutants must be eliminated, the average unit cost in a TDP system will still be the least cost. In a regulatory system without TDP's, the sum of the individual treatment costs is higher since each expanding facility must bear its own costs of increased treatment, some of which will be higher than the lowest cost achievable with TDP's.

Water Quality Consideration

One of the most important decisions the authority must make in designing any water quality management program for a particular water body is the form and stringency of the water quality goal. This goal is assumed here to be expressed as follows: A set of receiving water is chosen which represents a low extreme of body conditions assimilative capacity. These conditions, as usually represented for a stream by a low streamflow and high temperature, are referred to as the For example, the "sag point" in the levels of critical conditions. All of the authority's decisions dissolved oxygen concentration. regarding numbers of permits to issue, are assumed here to be undertaken on the basis of these conditions. Once the critical conditions have been determined, a mathematical model is assumed to be available for use by the authority to relate the water quality at all points in the receiving body to the waste discharge rates of each discharger.

Another policy decision is the basis of definition of the permits. Two definition bases are considered here. The first, called a BOD permit, entitles the holder to discharge a certain weight of BOD per day. The second type of permit entitles a discharger to deplete the dissolved oxygen at a specific location in the watercourse by a certain amount, as predicted by the water quality model for the critical conditions chosen. It is termed a Dissolved Oxygen Deficit Contribution permit (DODC). A DODC permit corresponds to a BOD permit of a certain size when held by a given discharger. However, unlike the BOD permit, it is revalued when transferred to another location [13, 14].

Water quality problems depend in part on local physical features with the type of trading restrictions chosen by the authority varying from one water body to another. However, the efficiency achieved by the TDP system comes about by letting the most efficient plant perform most of the waste removal without regard to where it is located, except when its location affects its cost of treatment. Thus, to maintain a specified water quality profile, the authority must recognize that the effects of discharges on water quality are different for different discharge locations and must formulate the effluent permits accordingly.

This research assumed seven participants located within a given zone to allow one-to-one trades of permits. The definition base for the permits is pounds of BOD per day (Lbs-BOD/day). A simulation model of water quality (QL2SMG) is used to estimate the relations between dischargers and DO levels at various locations along the stream.

An Overview of Simulation Gaming

Simulation gaming is described by Wood [15] as follows: "As a form of simulation model, gaming is similar to other simulations where the major purpose is to understand dynamic process. While the approach emphasizes process, it attempts to comprehend human activities as the products of indeterministic forces which can lead to any one of a possible range of outcomes, and is in essence a probabilistic approach. Where gaming simulation differs from other methods is that it attempts

<¹²

to provide experience of a 'real world' decision making situation, where goals have to be formulated, problems evaluated and judgment exercised".

Because of the complexity of human nature, it is difficult to describe the social and political system in terms of ordinary equations. Simulation gaming is designed to overcome this difficulty. As its name implies simulation gaming comprises two basic components: gaming, involving interaction between human "players", and simulation, involving interactive computer facilities [16].

Simulation gaming can be traced back to the mid-1950s when Rand Corporation developed "crisis game". This game provided foreign policy makers with a set of useable alternatives in the event that similar crises actually occurred [17]. Since that time, the number of simulation games has increased at a rapid rate. Currently, simulation gaming is widely used for amusement, education, and research.

Although still somewhat of a novel concept, simulation gaming is becoming accepted as a tool in the analysis of water resource systems, especially when decisions are likely to involve conflict and compromise. Wright and Howell [18] described a simulation gaming analysis of a water resource development issue in New South Wales. Johnson and Whitehead [19] elaborate on the value of simulation gaming in increasing the awareness of planners involved in water resource issues. Diamond et al. [20] discuss the design of simulation games for teaching and researching drought management.

One of the most recent and successful applications of water resource gaming occurred in 1982, when a one-day exercise was conducted in Washington D.C. The focus of the exercise was on reservoir operating policy in the Potomac River Basin. The water supply situation in and around the Washington D.C. area has been the source of considerable controversy for many years. Three agencies are responsible for supplying water, primarily from the Potomac River, to the 2.5 million residents of the region. Complicated relationships have evolved between these agencies as to how water should be allocated during periods of low flow in the Potomac River. Traditionally, there have been many disputes and little cooperation between the agencies. As a result, what should have been an adequate supply of water to the region during dry periods has been allocated inefficiently, and the reliability of the regional water distribution scheme has been questioned.

A group of researchers at Johns Hopkins University developed an interactive simulation model of the Potomac River Basin water system. This model, the Potomac River Interactive Simulation Model (PRISM), was to be used as a research and learning tool for those groups involved in the water supply planning in the region. Though PRISM was valuable as an aid in identifying alternative management strategies, it was even more effective when incorporated into a simulation gaming exercise. The exercise brought together many of the key decision makers from each agency and from other groups involved with water supply management. Interacting with PRISM and among each other, these groups gained insight into many of the conflicts involved in the water supply issue. As a result of the research at Johns Hopkins, many of the obstacles which previously prevented efficient regional water management were re-The investigation approach was so successful that the project moved. was considered for the 1983 Outstanding Engineering Achievement Award [21].

A literature search has unveiled no game designed for water quality management. Timely and efficient disposal of the waste generated by the manufacturing plant requires engineering as well as This is because most companies have to operate economic analysis. under a permit issued by some state regulatory body. Typically these permits allow companies to release a specified maximum amount of waste with certain biochemical characteristics. The companies may also have the choice of releasing the waste into the city sewer system and paying the municipality a user charge. Obviously the decision on proper disposition of the waste can involve evaluation of several alternatives based on economic analysis. A decision to expand waste treatment also has to consider production forecasts. Thus, this game would be valuable not only for teaching aspects of water quality decisions, but it could also be used as a research tool for understanding economic issues of water quality management.

The Benefits of Simulation Gaming

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<u>Research Tool</u>. Simulation gaming may provide one or more advantages as research tools including: 1) Ease of observation and data collection; 2) Reproducibility; 3) Lower cost; and, 4) Ability to study phenomenon where direct research is not politically acceptable [22]. As a result of these advantages, simulation gaming has been used for research in psychology [23], sociology, the military, economics [24] and various other fields.

<u>Teaching Tool</u>. Simulation gaming may also provide one or more advantages as a teaching tool including: 1) Students exhibiting a high degree of interest and participation; 2) Students experiencing making managerial decisions; 3) The opportunity to integrate concepts from diverse areas of courses; 4) The experience of living with past decisions; and, 5) The decision-making experience is condensed into a relatively short period of time [25].

Disadvantages of Simulation Gaming

Aronson and Carlsmith [26] delineated two types of realism: mundane and experimental. Mundane realism relates to how likely it is that the events occurring in a laboratory are likely to occur in the real world. Experimental realism relates to how seriously the subject takes the experiment. Some users have the tendency to treat simulation as a "game" rather than to treat problems with experimental realism. This results in lack of incentive to perform the game well. Nees [27] noted that the participants in her simulation "did not bear the consequences of their decision. Neither were they penalized for failure, nor did they have to live with their undertakings after the simulation was over".

The "lack of incentive" issue is intertwined with another issue, regarding the nature of the subject group, whether they are college students or managers. On one hand, the grade environment which exists in the classroom places an incentive on student subjects to do well. Slusher, Sims and Thiel [28] found that semester-long involvement in a competitive learning environment provides a high and consistent incentive. On the other hand, when Bass [29] discussed the high motivation level usually found among manager-subjects, he observed that "real managers try to do their best when confronted with simulated management problems". Incentive for play was attributed to competitive desires and to a sense of loyalty to one's team.

The best answer to the guestion of whether the game has experimental realism involves a comparison of the subjects' game behavior with their actual behavior. Obviously, this can present serious problems in the case of student subjects as they cannot be expected to be making actual decisions for most topics under investigation. However, there have been studies which compared the performance of manager-subjects in simulation games to their performance in the workplace. Babb and Bohl [30] found 70% of farmers', initial pricing decisions in a farm management game to be consistent with their real life decisions. Jones and Babb [31] found that retail managers' pricing decisions agreed with their real world behavior only about half the time. However, they did find that their non-price behavior was nearly identical to that used in the simulation games.

Babb, Leslie, and Van Slyke [32] noted that there are striking differences in game behavior and in results between students and experienced managers. Students are affected much more by information provided them, whereas managers apparently rely on experience. Managers follow more conservative policies then students, while students are more erratic in their decisions. Apparently students feel the need to learn something about the industry by experimenting with the game. Student performance was usually much lower than experienced managers in early decisions but quickly came to an equal level. The general conclusion is that experimentation on the subjects' part does take place and that this experimentation is not likely to be done in a real world environment. However, even when student subjects are used, game behavior moves toward real life after a few decisions.

The field of simulation games is still growing at a prodigious rate, as measured by their commercial availability. Yet many reports indicate that simulation games are not entering the classroom as fast as they are proliferating on publisher's lists. The major reason is that simulation games are often viewed as highly complex, strange, slightly upsetting phenomena by teachers who have never used them. Some professors who initially undertake the usage of simulation exercise because they think it represents an escape from their teaching duties soon find that it requires a great deal more of their time than they had expected. In most cases, more time than they normally would have spent using their traditional methods. The net result being that certain professors drop the use of simulation games and return to the traditional methods with which they feel more comfortable [33].

CHAPTER III

METHODOLOGY

Description of the Game

Basic Game Structure

The flow chart (Figure 3) illustrates the basic structure of the The game begins with a detailed description (illustrated in game. Appendix A) of the firm or of the municipality that the participants This includes data on production plans, costs of are to represent. production, and the relationships between the output and effluent of various pollutants. The municipal managers are given data related to city waste treatment and to the requirements from the firms in the area for waste treatment. The water quality standards that the firm or the municipal plant must meet are also given to the participants. Thev also receive information on legal consequences of releasing effluent without treatment. This includes the estimated penalties and probability of getting fined.

Besides the production data, the manager is also given a complete list of alternatives (described later in detail). Each alternative comes with its cost effectiveness figures. Costs are given for various stages of treatment for each plant capacity [34].

After considering all the information, the participant evaluates the alternatives and makes a decision in terms of production volumes,

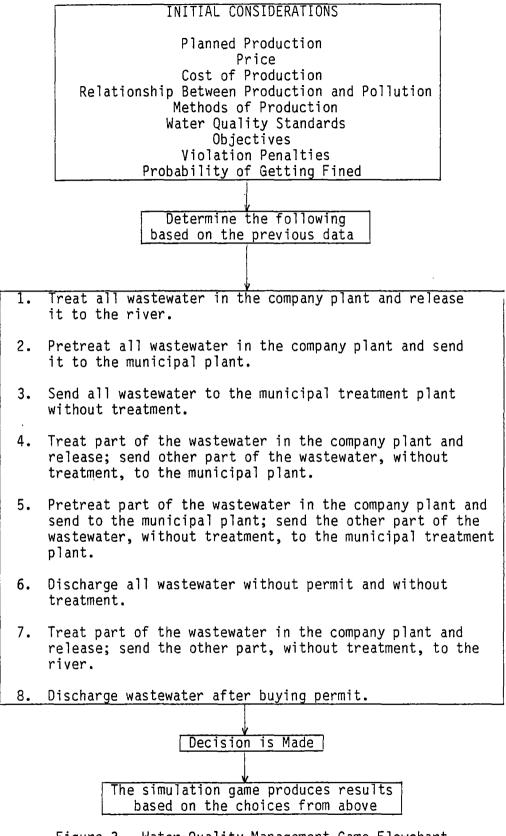


Figure 3. Water Quality Management Game Flowchart

pollutant disposal alternatives, and size-cost data. Also included in the decision is the choice of expanding current treatment capacity which could be available two periods later.

The decision-making is followed by the entry of the data into the computer. Then the simulation game is started, and the gaming program prepares two reports. From all the decisions, the production-pollution relationships determine the generated pollutants. The individual cost and quality of effluents are derived from the abatement options of the teams. The game also uses the QL2SMG model to calculate the water quality for the whole region. The QL2SMG model considers pollution from several sources at several points and calculates water quality in terms of BOD and dissolved oxygen concentration.

Each participant obtains a summary of results of his or her decisions, including the actual cost incurred, fines for violating water quality standards, pollution clean-up alternatives, etc. The information also includes the overall water quality at different locations in the area. The game is then repeated for the next period, i.e., the next quarter, details of which will be given later.

Participant Characteristics

Five industrial firms and two municipalities constitute the region simulated by the game in its current version. A team represents either a firm or a municipality. Using teams of two or more for each industry or municipality, the game can include more participants in each region. Figure 4 gives a schematic of the region. It also indicates that industries and cites are situated along a river and its tributaries. The numbered elements in the figure represent "mile-marks". Thus, for

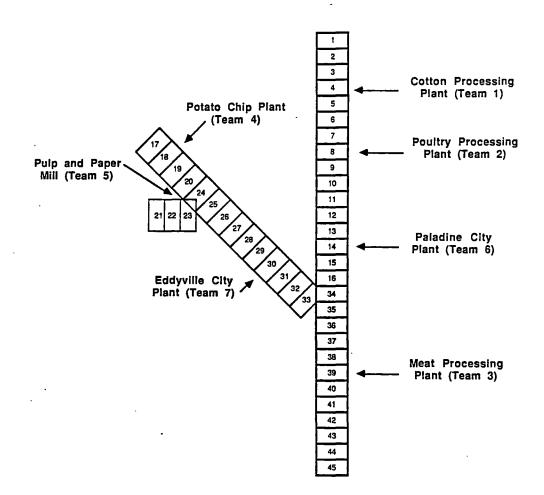


Figure 4. Typical River Region Consisting of Industries and Cities

example, team one is four miles upstream from team two. The first three industrial firms are assumed to be in Paladine City and the others are in Eddyville. The five industries selected in this game are industries which generate significant amount of industrial wastes.

The plants represented by the industrial firms are processors of cotton, poultry, and meat, and factories making things such as potato These plants could be either small- or chips and pulp-and-paper. medium-sized. Each participant gets a description of the production function of the firm. The data involve the production forecast for four guarters, associated expected wastewater flow rates in million gallons per day (MGD), and influent BOD in milligrams per liter (mg/1). The data also include the permitted discharge to the river in terms of maximum flow rate (MGD) with limits on BOD concentration in the effluent and with the capacity of the available wastewater treatment plant. The estimated fixed as well as variable costs of operating wastewater treatments at various levels are also provided. In case a firm decides to use the municipal plant for disposal of wastewater, the participant is given the estimated user charge at different flow rates and pretreatment levels. Finally, a table containing costs of larger plant sizes accompanies the information package to help in making decisions on upgrading the plant.

The five industrial firms and the two municipal plants have a wide range of plant sizes, permits, and production forecasts. Table I contains a summary of starting values of permitted discharges, and plant sizes. The information is realistically based on interviews with representatives of many of the regulatory agencies in the State of Oklahoma.

TABLE I

				• ,
Team	Max. Permitte Flow (MGD)	d Discharge BOD (mg/l)	Plant Ca Flow (MGD)	BOD (mg/l)
1	1.7	30	1.5	20
2	0.38	24	0.45	24
3	0.03	40	0.05	70
4	0.04	20	0.05	20
5	2.00	20	2.00	40
6	15.00	45	16.00	40
7	3.00	10	5.5	10

INITIAL WATER PARAMETERS FOR THE PARTICIPANTS

Decisions and Alternatives

By learning the key concepts and performing skills used in a decision-making process, the participants gain the ability to frame a problem, identify useful data, predict and bargain permit prices, and render judgments about the appropriate actions.

The simulation game plays eight periods, each period representing one season. The first four periods don't involve the TDP case, while the later four periods cover the TDP case, in order to make a fair comparison, the production volume of the first four periods should equal that of the following four counterpart periods: i.e., the first period production volume is the same as that of the fifth period production volume. Three types of decisions are made during the first four periods. The participants determine the production volumes and choose any of the first six alternatives in disposing of the expected waste in the current period. The next step is to decide whether to upgrade the treatment plant. During the final four periods, participants have to make four kinds of decisions. First they negotiate the transfer of discharge permits with the other participants at a mutually agreeable price. Those who want to buy permits can only choose alternative 1, 4, 7 or 8, but if they want to sell permits, they can choose any of alternatives 1 to 7 to treat their wastewaters and finally, decide wheather to upgrade their existing plants or not. If they want to upgrade their plants, the upgrades take two periods of time.

The basic production-pollution relationships and production costs are a built-in feature of the program. The eight alternatives are:

- Treat everything in the company plant and release to the river.
- Pretreat everything in the company plant and send to the municipal plant.
- 3. Send all waste to the municipal plant without treatment.
- 4. Treat part in the company plant and release; send the other part of the wastewater, without treatment, to the municipal plant.
- Pretreat part in the company plant and send to the municipal plant; send the other part, without treatment, to the municipal plant.
- 6. Discharge without permit and without treatment.
- Treat part in the company plant and release; send the other part, without treatment, to the river.
- 8. Discharge wastewater after buying permit.

The first alternative requires treating the waste entirely in the

company plant. The company then incurs capital and operating costs of a treatment plant. The next four alternatives use the municipal plant to some extent, involving the expense of a user charge. The sixth alternative is unacceptable. The last two alternatives are used for the TDP case only. If a company is caught discharging without permit and treatment, a heavy fine is imposed which simulates a penalty and bad publicity.

It is not easy to decide among these alternatives. The participants must calculate the total cost of each alternative. The alternatives involving partial treatment require consideration of the Some of the extent of treatment and of its effect on total cost. alternatives may not be practical due to the capacity of the treatment plant and/or the permitted discharge. For instance, if a firm has a wastewater treatment plant with a design capacity of 0.08 MGD flow and expects 0.09 MGD flow during a certain quarter, it cannot choose alternative 1, treating everything in the company plant and releasing to the river. Thus, the participant has to select the practical set of alternatives first, analyze their implications, and make a decision. The continuity from quarter to quarter is also an important issue to consider. The long term effect of a strategy cannot be ignored.

The decision to upgrade the plant may affect future decisions as well. The benefits of a larger plant, such as "pretreat the waste and release to the city sewer", or "treat part of the waste and release to the city sewer", have to be considered against the costs of these benefits as well as costs of alternatives. These two decisions require a thorough analysis of marginal costs of each alternative.

The Conceptual Model of Game Program

There are five programs involved in this simulation game: (a) the participant input program, which lets the participants input their decision; (b) the proctor input program, which generates the QL2SMG input format for executing the QL2SMG program; (c) the cost program, which generates a financial report for each team; (d) the QL2SMG package, which calculates the water quality report for the whole region; and (e) the SAS package, which assesses the impacts of water quality and cost between the TDP system and the non-TDP system.

Participant Input Program

After participants use computer command language to enter the program, the program will read plant design capacity, TDP price and permit numbers from different data files automatically. Afterwards, participants should input their team numbers (teams 1 to 5 represent industrial firms; teams 6 and 7 indicate municipal plants), period number and production volumes. The program will generate wastewater flow rates and BOD concentrations by built in production-pollution relationships. The flowchart of this program is found in Figure 5. The participant input program is given in Appendix F.

If the participants want to buy permits, they can choose alternative 1, 4, 7 or 8, but if they decide to sell permits, they can choose any alternative from 1 to 7 to treat their wastewater. Finally they are asked wheather to expand the existing plant or not. The optimal size of the plant should be the size that minimizes construction costs and penalty costs associated with inadequate capacity.

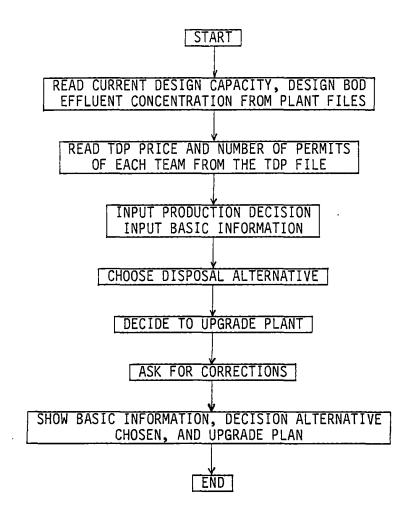


Figure 5. Participant Input Program Flowchart

Alternatives

There are eight alternatives involved in the treatment options.

<u>Alternative 1</u>: Alternative 1 states "Treat all wastewater in the company plant and release to the river". This alternative will be restricted by five factors: (a) Treated wastewater flow rate should not exceed the plant's design capacity, (b) Treated wastewater flow rate should not exceed the maximum limitation of wastewater flow rate to the river, (c) Treated wastewater BOD effluent concentration should

not exceed the design BOD effluent concentration, (d) Treated wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the river, and (e) The design BOD effluent concentration should not be larger than the allowed BOD effluent concentration to the river. For the TDP case, this restriction will be released. In periods 5, 6, 7 and 8, the BOD effluent concentration is calculated by the formula:

$$BODE = (SBOD \times SQ)/Q1 + TDP$$
(Eq. 1)

Where BODE is the treated BOD effluent concentration (mg/l)

- SBOD is the allowed BOD effluent concentration to the river (mg/l)
- SQ is the maximum limitation of wastewater flow rate to the river (MGD)
- Q1 is treated wastewater flow rate (MGD)

TDP is the number of trading permits

Example: The allowed BOD effluent concentration to the river from plant 1 is 30 mg/1 and the expected wastewater flow rate is 1.35 MGD in period 3 and period 7. Under the non-TDP case, team 1's discharged BOD effluent concentration should not exceed 30 mg/1. But during period 7, if this team does not trade permits, the BOD effluent concentration is 37.6 mg/1.

<u>Alternative 2</u>: The second alternative states "Pretreat all wastewater in the company plant and send to the municipal treatment plant". This alternative will be restricted by three factors: (a) Pretreated wastewater flow rate should not exceed the design capacity, (b) Pretreated wastewater BOD effluent concentration should not exceed the design BOD effluent concentration, and (c) Pretreated wastewater BOD effluent concentration should not exceed the allowed BOD effluent concentration to the municipal treatment plant.

<u>Alternative 3</u>: The third alternative states "Send all wastewater to the municipal treatment plant without treatment". This alternative will be restricted by BOD effluent concentration of discharged wastewater, which should not exceed the allowed BOD effluent concentration to the municipal treatment plant.

Alternative 4: The fourth alternative states "Treat part of the wastewater in the company plant and release; send the other part of the wastewater, without treatment, to the municipal plant". This alternative will be restricted by seven factors: (a) Treated wastewater flow rate should not exceed the production wastewater flow rate, (b) Treated wastewater flow rate should not exceed the plant's design capacity, (c) Treated wastewater flow rate should not exceed the maximum limitation of wastewater flow rate to the river, (d) Treated wastewater BOD effluent concentration should not exceed the design BOD effluent concentration, (e) Treated wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the river, (f) Discharged wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the municipal treatment plant, and (g) The design BOD effluent concentration should not be larger than the allowed BOD effluent concentration to the river (for the TDP case, this restriction is cancelled).

<u>Alternative 5</u>: The fifth alternative states "Pretreat part of the wastewater in the company plant and send to the municipal plant; send the other part of the wastewater, without treatment, to the municipal plant". This alternative will be restricted by four factors: (a)

Pretreated wastewater flow rate should not exceed the production wastewater flow rate, (b) Pretreated wastewater quantity should not exceed the design capacity, (c) Pretreated wastewater BOD effluent concentration should not exceed the design capacity for BOD effluent concentration, and (d) Pretreated and discharged wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the municipal treatment plant.

<u>Alternative 6</u>: The sixth alternative says "Discharge all wastewater without permit and without treatment". This alternative does not have any restrictions.

<u>Alternative 7</u>: The seventh alternative states "Treat part of the wastewater in the company plant and release; send the other part, without treatment, to the river". This alternative will be restricted by three factors: (a) Treated wastewater flow rate should not exceed the production wastewater flow rate, (b) Treated wastewater flow rate should not exceed the plant's design capacity, and (c) The discharge permitted is equal to the initial permit holdings plus traded permits. The teams must be careful because this situation can only exist in the TDP case.

<u>Alternative 8</u>: The eighth alternative says "Discharge wastewater after buying permit". This alternative will be restricted by the fact that the discharge permit needed is equal to the initial permit holding plus purchased permit numbers (for the TDP case only).

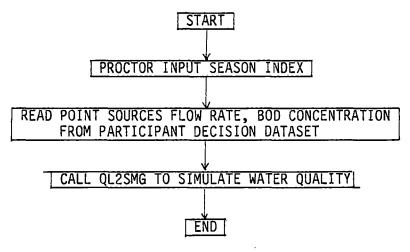
The upgrade plan is restricted by: (a) Future design capacity is not less than the current design capacity, and (b) Future design BOD effluent concentration is not larger than the current design BOD effluent concentration.

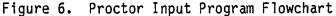
In the TDP system, each permit authorizes a specific rate of discharges, say one Lb-BOD/day. After initial distribution of permits among participants, if the participants still want to purchase permits, they can slacken wastewater discharge, i.e., the current maximum of limitation of BOD effluent concentration will be increased. For example, the current design BOD effluent concentration for team 3 is 70 mg/l, the maximum limitation of BOD effluent concentration is 40 mg/l and expected wastewater flow rate is 0.030 MGD. Owing to the restriction alternative 1 (e), "The design BOD effluent concentration should not exceed the allowed BOD effluent concentration to the river", under the non-TDP system, they can never choose alternative 1 for disposal of their wastewater, but under the TDP system if they purchase permits for 7.51 Lb-BOD/day, their discharged BOD effluent concentration can be 70 mg/l. In other words, the maximum limitation BOD effluent concentration is increased to 70 mg/l. Therefore, team 3 can choose alternative 1.

In certain cases, participants decide to expand the existing treatment facilities. This decision will invoke additional capital costs. These costs will vary with the wastewater design flow and BOD design effluent concentration. Once the wastewater treatment facilities are defined in terms of wastewater design flow and BOD design effluent concentration, the capital costs become fixed costs until further decisions are made to augment the treatment plant again. The additional capacity for the plant will not become available until two periods after the decision to upgrade the plant has been made.

Proctor Input Program

The stream flow rate and water temperature are the most important physical parameters that affect the capacity of a stream to assimilate BOD effect. In this program, it is assumed that flow and water temperature vary in a predictable sequence over the course of an annual cycle. For control purposes, the year is divided into four periods, each exhibiting constant stream conditions. After the proctor chooses a season index (1 for spring, 2 for summer, 3 for fall and 4 for winter), the program will set the suitable flow rates and temperatures for each computational element automatically. The discharge loading at various points is read from participant decision datasets and used to define the point source conditions. Finally, this program will generate an input format for the QL2SMG program (See Figure 6). The proctor input program is given in Appendix G.





The purpose of the cost program is to calculate the capital costs (See Figure 7), operation costs, and total net income for each participant. Considerable effort was made to ensure the accuracy of the relationship included in the cost program. The Fortran program for cost calculations is given in Appendix E.

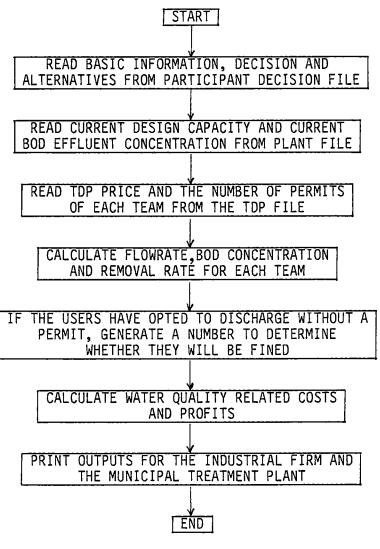


Figure 7. Cost Program Flowchart

<u>Fixed Cost and Variable Cost</u>. Wastewater treatment costs consist of both the capital cost incurred to construct the facility and operation and maintenance costs (O&M) associated with treating the waste stream. Capital cost would be expected to be related to design flow and performance, while O&M cost would be related to actual flow and performance. Design flow is used in the equation for capital cost and actual flow is used in the equation for O&M cost. Frass and Munley [35], based on statistical analysis, proposed the equations (2) and (3). C1 and C2 are used here to represent the cost adjustment factors for small-sized plants.

Fixed cost

=
$$78239 \times DQ^{0.89} \times BB0D^{0.24} \times DB0D^{0.16} \times 0.25 + C1$$
 (Eq. 2)

<u>User Charge</u>. User charges are defined as those charges assessed against contributors to the treatment works for their proportional share of operation and maintenance costs. Considering constrained capacity and willingness to buy permits, dischargers decide whether to discharge pollutants to the municipal plant or not. If the discharged

BOD concentration exceeds 250 mg/l, the discharger must pay an additional charge for high-strength wastewater. Based on a statistical analysis Dyer et al. [36], proposed a formula to calculate user fees. For the purpose of this dissertation, this formula was modified because the formula establishes user charges on the basis of BOD, suspended solids, and phosphorous contents of the wastewater. BOD is assumed here to be the only criterion for measurement of water quality.

User Charge = $(Q1 \times 0.106) + (Q2 \times 0.443 \times (BOD - 250))$ (Eq. 4) Where Q1 is the average annual discharge rate expressed in

thousand liters/year

Q2 is the average annual discharge rate expressed in million liters/year.

<u>Permit Price</u>. The total permit cost is equal to the unit permit price multiplied by total permit numbers. Dischargers with an excess of TDP's would offer them for sale. If the team decides to sell permits, the total permit price will be deducted from the water quality related cost. Those with a deficiency would seek to purchase them. If the team decides to buy permits, the total permit price will be added to the water quality related cost.

Enforcement. The idea of computing uncertainty of penalty is based on probability. The cost program uses the pseudo-random number uniform distribution (RANF) to generate a random number between 0 and 1. If a team decides to release untreated wastewater without appropriate permits, the game program attempts to simulate reality by randomly deciding whether the team is caught by the inspector, assuming that there is a 60% probability of getting caught. Therefore, if the outcome is less than 0.6, the team will be forced to pay a large amount in fines.

The fine for exceeding the allowable discharge or pollutant concentration should be greater than the price of an effluent permit in order to encourage the use of the effluent permit market to allocate discharges throughout a river basin. As the prices of permits rise, the incentive to discharge illegally grows; consequently, the penalty for non-compliance should increase.

<u>Water Quality Related Cost</u>. The water quality related cost is broken into five areas: (1) fixed cost, (2) variable cost, (3) user charge, (4) permit expense, and (5) penalty fine. Fixed cost reflects all construction cost for the treatment plant. The variable cost is all labor, material and supply costs necessary to operate the process after construction. All these costs must be estimated separately and added together to reflect total system costs.

QL2SMG Water Quality Model Description

Introduction

The model selected for this simulation game is an updated version of the stream quality model QUAL-II which was originally developed in 1973 by Water Resources Engineers, Inc. for the systems development branch of the U.S. Environmental Protection Agency. QUAL-II has been widely used and accepted across the country for the purposes of wasteload allocation and water quality management planning.

The updated version of QUAL-II that is used for this study is appropriately named QL2SMG, developed by the Southeast Michigan Council of Governments (SEMCOG). Although several modifications and capabilities were added to the original program, the model package still retains the basic QUAL-II structure. The QL2SMG model will predict both the temporal and spatial quantities of the following water quality variables; temperature, conservative mineral, carbonaceous BOD, algae, phosphorus, nitrogen, dissolved oxygen, and coliform [37, 38].

QL2SMG can simulate either the steady-state or the psuedo dynamic response of a river system to a set of specified input conditions. Steady state is applied in this dissertation. QL2SMG is a finite difference solution of the one-dimensional advection-dispersion equation. In addition, the program has the capability of determining the stream flow required to maintain a preselected target dissolved oxygen level [39, 40].

Theoretical Consideration

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BOD, DO, and hydraulic conditions are major concern parameters in this dissertation. Each of these variables are discussed in the following section. Table II lists the usual range of numerical values for these variables. The rest of the parameters can be found in reference [41].

INDLE II

INPUT PARAMETERS FOR QL2SMG

Name	Range of Values
D	3.0 - 100.0
К1	0.1 - 2.0
K2	-0.36 - 0.36
КЗ	0.0 - 10.0
К4	0.0 - 5.0
wl	1.4 - 1.8
w2	1.6 - 2.3
w3	3.0 - 4.0
w4	1.0 - 1.14
u	1.0 - 3.0
p	0.05 - 0.5
ul	0.1 - 0.5
u2	0.5 - 2.0
a	0.22 - 0.30
b	0.30 - 0.37
с	0.43 - 0.51
d	0.38 - 0.61

<u>Advection-Dispersion Equation</u>. The QL2SMG model numerically solves the advection-dispersion mass transport equation for each water quality constituent being modeled. This equation represents a differential mass balance on the volume of each computational element in the system.

@C/@t = @(D@C/@X)/@X - @(UC)/@X + Z
(Eq. 5)
(1)
(2)
(3)
(4)
where: C = concentration (mg/l)
X = distance (L)
t = time (T)
U = average stream velocity (L/T)
Z = source or sink (mg/l/T)
D = dispersion coefficient (L x L/T)

The first term (1) represents the time rate of change of concentration, the second term (2) represents transport of mass by longitudinal dispersion, the third term (3) represents the advective component of mass transport, and the last term (4) is the sum of all sources and sinks of material. In a steady state simulation, the first term is omitted from the mass balance.

<u>Hydraulics</u>. QL2SMG assumes steady, gradually varied hydraulics. Steady hydraulics implies that the flow, velocity, width and depth at a given point in the stream are constant with time. Gradually varied flow allows these four factors to vary in the longitudinal direction, from element to element and from reach to reach. The flow in each computational element is calculated from a mass balance on the forcing functions applied to the element and inputs from upstream elements. Velocity can be found by $V = aQ^b$, and depth is calculated as $D = cQ^d$.

where: a = velocity coefficient

b = velocity exponent

c = depth coefficient

d = depth exponent.

<u>Carbonaceous BOD</u>. Carbonaceous BOD may be expressed as a three term equation. The general equation for BOD is: L(T) = F - K1 L - K2 L (Eq. 6) where: L(T) = ultimate BOD concentration at time t (mg/l) F = input forcing function for carbonaceous BOD (mg/l) K1 = bio-oxidation coefficient for CBOD (1/day) K2 = coefficient for settling and scour effects L = ultimate CBOD concentration in the computational

element (mg/l).

<u>Dissolved Oxygen</u>. The reactive component of the source-sink term for dissolved oxygen is written for bio-oxidation of CBOD, reaeration, sediment oxygen demand, net oxygen production by algae, and oxidation of ammonia and nitrite. All of these factors are modeled as first order kinetics, except the SOD effect which is zero order.

 $d0/dt = F + K3 (c^* - c) + (w1 u - w2 p) A - K1 L -$

K4/Ax - w3 u1 N1 - w4 u2 N2 (Eq. 7)
where: F = input forcing function for dissolved oxygen (mg/l)
c* = saturation dissolved oxygen concentration (mg/l)
 (temperature dependent)
 c = dissolved oxygen concentration (mg/l)

e = arssorved oxygen concentration (mg/1)

wl = ratio of oxygen production per unit of algae growth

w2 = ratio of oxygen uptake per unit of algae respired

w3 = ratio of oxygen uptake per unit of ammonia

nitrogen oxidation

- w4 = ratio of oxygen uptake per unit of nitrite
 nitrogen oxidation
- k3 = reaeration rate (1/day) (temperature dependent)
- k4 = rate coefficient for sediment oxygen demand
- u = local specific growth rate of algae
- p = local settling rate for algae
- Ax = average cross sectional area of the computational
 element
- u1 = rate of conversion of NH3-N to NO2-N (1/day)

(temperature dependent)

- u2 = rate of conversion of nitrite to nitrate (1/day)
 (temperature dependent)
- N1 = ammonia nitrogen as N (mg/l)
- N2 = nitrite nitrogen as N (mg/l).

The Program

The computer program for the water quality model QL2SMG consists of a MAIN program and 23 subroutines. The MAIN program calls subroutine INDATA which reads and echo prints the input data. The main program then controls the sequence of subroutine calls for routing the desired water variables. It calls subroutines HYDRAU and TRIMAT to set up the hydrodynamic components of the mass balance. It then completes the balance by calling the constituent subroutine for the water quality variable being modeled. The resulting set of simultaneous equations is then solved in subroutine SOVMAT. If more than one water quality variable is being simulated, the mass balance is re-established in the appropriate subroutine and solved. When all the water quality variables have been solved for each computational element, the program time counters are advanced to the next time step. In the steady state mode, the final solution is obtained on the first time step although a number of interations may be required to balance the algae, nitrite, phosphorus, and temperature computations [42].

<u>Input Option</u>. In order to save time and effort, the input program can formulate QL2SMG package input data from an external file. One can specify the expected ambient temperature, flow conditions in the region and so on. All such environmental conditions can automatically be generated through this program if one specifies a season index for the quarter under consideration. The four sets of environmental conditions are built in, one for each season.

<u>Input Requirements</u>. Input information is provided to QL2SMG in groups called "data types". As a general rule, the different data types are input by reach, starting with the headwaters and proceeding downstream. All input data are read in by subroutine INDATA, with the exception of local climatology.

The descriptive titles of the data types are listed here, the detailed summary can be found in reference [43].

- 1. Program Titles.
- 2. Data Type 1; Program Control Data.
- Data Type 1A; Algae Production and Nitrogen Oxidation Constants.

4. Data Type 2; Reach Identification and River Mile Data.

- 5. Data Type 3; Flow Augmentation Data.
- 6. Data Type 4; Computational Element Flag Field.
- Data Type 5; Hydraulic Data for Determining Velocity and Depth.
- Data Type 6; Reaction Coefficients for Deoxygenation and Reaeration.
- 9. Data Type 6A; Algae, Nitrogen, and Phosphorus Coefficients.
- 10. Data Type 6B; Other Coefficients (SOD, etc).
- 11. Data Type 7; Initial conditions.
- 12. Data Type 7A; Initial conditions (Algae and Coliform, etc.).
- 13. Data Type 8; Incremental Inflow.
- 14. Data Type 8A; Incremental Inflow (Algae and Coliform, etc).
- 15. Data Type 9; Stream Junction Data.
- 16. Data Type 10; Headwater Characteristics.
- 17. Data Type 10A; Headwater Characteristics (Algae and Coliform, etc.).
- 18. Data Type 11; Waste Inputs and Withdrawals.
- Data Type 11A; Waste Inputs and Withdrawals (Algae and Coliform, etc.).
- 20. Local Climatological Data.

<u>Output Information</u>. The output from QL2SMG consists of three parts: an echo-printing of the input data (optional), intermediate summary (optional), and a final summary.

 INPUT DATA - All input data (except local climatology) are echo printed by QL2SMG.

2. INTERMEDIATE SUMMARY - The intermediate summary is a brief

listing of computed values of the simulated water quality variables for each computational element in the basin. In the steady state mode it is printed after the steady state solution has converged.

3. FINAL SUMMARY - The final summary is a detailed listing of the results of the simulation and is printed in two parts. The first part contains location, flow and forcing function data as well as the final values of the simulated water quality variables for each computational element in the system. The second part contains river mile location, velocity, and depth data as well as the values of the reaction coefficients for each computational element in the system.

Result Analysis

The reason for testing the TDP system is to see if it reduces water quality related cost without any adverse effects on the water quality. The measure of the true gain is when: X(po) > X(pe). (Where X = mean value of a performance variable, X(po) are data taken at the post-test [TDP system] period, and X(pe) are data taken at the pre-test [non-TDP system] period.) If X(po) is greater than X(pe), then statistical significance must be tested.

The successful statistical test requires rejecting a null hypothesis which states that the true mean of both populations are equal and accepting an alternative hypothesis which says that the true mean of these two populations is significantly different. To test the null hypothesis, some degree of desired significance is established and this factor determines the critical region between acceptance and rejection of the sampling distribution. For the paired comparison, there is a test presented by Wilcoxon to test wheather a particular sample came from a particular population. If the probability of significance is greater than 0.05, the null hypothesis is accepted but if it is less, then the null hypothesis is rejected. Rejecting the null hypothesis means accepting the alternative hypothesis.

The usual parametric counterpart to the Wilcoxon nonparametric test is the "paired t-test". If the sample size is less than 15, it is appropriate to use a Wilcoxon signed ranks test instead of the Student's t-test. The analyses in Chapter V are based on the Wilcoxon Ranks Test [44].

CHAPTER IV

APPLICATION

Game Operation

Computer Support of the Game

The players interface with the simulation when they input their data, after making their decisions based on engineering considerations and economic principles. The computer program is used to record these decisions and to analyze their effects. The overall game program consists of a number of computer programs, command procedures and datasets. Figure 8 presents a schematic of these programs and datasets.

<u>Interactive Environment</u>. The first of these two command procedures for interaction in the game is used by participants to enter their decisions. This command procedure (illustrated in Appendix D) arranges appropriate datasets, calls the participants input program, prompts the participants for decisions, allows corrections to be made, and records the decisions in two datasets. One dataset records the details of the decision for the current period's wastewater disposal, and the other dataset records the plant size available for two periods later, based on the upgrade decisions. Two periods are required to upgrade a plant.

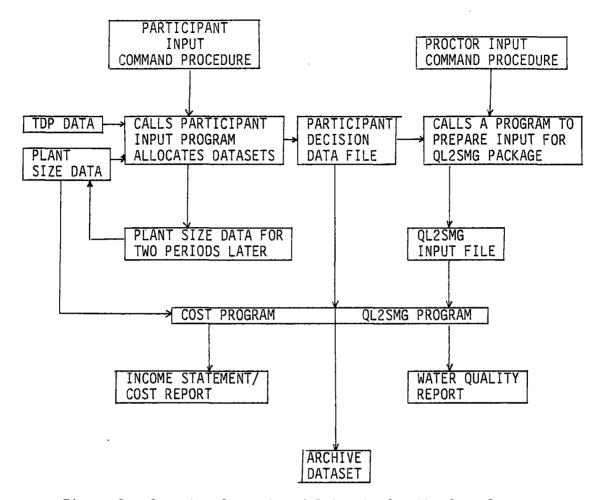


Figure 8. Computer Support and Datasets for the Game Program

The second command procedure (Appendix C) is used by the proctor to enter his or her decision. This command procedure arranges participant decision datasets, calls the proctor input program, prompts the proctor for the season index, and records the output in a dataset. This dataset is prepared as input for the QL2SMG program. The command procedure then submits two batch jobs, one for the execution of the cost program and the other for the QL2SMG program. The program also writes all relevant information onto the current history file and appends it to the archival dataset for further Statistical Analysis System (SAS) analysis. The whole process is, therefore, automated. The proctor just needs to log on the computer once a week and input the seasonal index.

The game is programmed in FORTRAN for the interactive mode and delivered to the user in load module form. Participants need not have any prior knowledge of computer programming. The QL2SMG program, developed by the EPA, is also written in standard FORTRAN.

<u>Input by Participants</u>. Participants access the program through a password protected identification using remote terminals. They submit their decisions for the period of play in response to the questions from the interactive program. This program is "user friendly", which means that during the input mode, the participants can correct input errors easily. Through job control language manipulation, the decision dataset is created under a specified name and stored in a paritioned dataset form. During each decision period, the dataset reads decision data from the appropriate participant. If participants want to substitute new datasets, each decision dataset can be updated easily without interrupting the sequencing for input to the main program.

<u>Input by Game Proctor</u>. After all the decisions have been made and the data entered into a computer dataset, the proctor can specify the expected ambient temperatures and flow conditions of the region. Such environmental conditions can automatically be generated through a computer program if the proctor indicates a season for the specified quarter. Thus, four sets of environmental conditions are built into the program, one for each season.

<u>Game Program Calculation</u>. When the game participants and the proctor have entered their information, a cost program simulates economic effects of the decisions. Each team gets a financial report that includes the result of their decisions, upgraded plant capacity and cost analysis of their decisions. In addition, reports for industrial firms include simplified income statements based on their production decisions and on fixed relationships between production, price, and cost variables. Table III illustrates a sample financial report.

TABLE III

SAMPLE FINANCIAL REPORT

WATER QUALITY SIMULATION GAME	
REGION : A GAME PERIOD : 6 REPORT FOR TEAM : 3	
DECISIONS FOR WATER QUALITY MANAGEM CURRENT DESIGN CAPACITY CURRENT DESIGN BOD EFFLUENT CONCENTRATIO CURRENT MAXIMUM LIMITATION OF BOD EFFLUE THIS IS INDUSTRIAL FIRM PRODUCTION FORCAST EXPECTED WASTEWATER FLOW RATE EXPECTED BOD INFLUENT CONCENTRATION	: 0.050 MGD N: 70.0 MG/L NT CONCENTRATION TO THE RIVER: 40.0 MG/L : 1.250 MILLION POUNDS OF PRODUCT : 0.047 MGD
THIS IS YOUR ALTERNATIVE DISCHARGE WITH PERMIT DISCHARGED WASTEWATER FLOW RATE DISCHARGED BOD EFFLUENT CONCENTRATION	: 0.047 MGD :400.0 MG/L
WATER QUALITY-RELATED COSTS QUARTERLY INVESTMENT AND FIXED OPERATIN OPERATION COSTS INDUSTRIAL USER CHARGES NUMBER OF PERMITS BOUGHT : 147.00 FROM UNIT PERMIT BUYING PRICE COST OF PERMITS TOTAL CURRENT COSTS	: 1604. DOLLARS : O. DOLLARS TEAM 6 TO TEAM 3
OTHER EXPENSES TOTAL EXPENSES TOTAL TAXABLE INCOME TAX ON CURRENT INCOME	: 2250000. DOLLARS : 1350000. DOLLARS : 225000. DOLLARS : 1586301. DOLLARS : 663699. DOLLARS : 305302. DOLLARS : 358397. DOLLARS

A second component of the game program simulates the water quality of the whole region based on discharges at various points and on environmental conditions. The QL2SMG package serves this purpose [45].

Game Administration

A region represented by seven teams is simulated by the game. Two of these teams represent municipalities; the others are industrial firms. In this game, two participants represent one team and the entire section simulates one region.

The game was designed to be played in a Natural Resource Economics class, an elective taken by Economics, Business and Civil Engineering majors. The class normally meets on Mondays, Wednesdays, and Fridays for fifty minutes. After the proctor covers the topics relevant to water quality management, the game is introduced and the participants are handed descriptions of the firms they represent. By Friday of each week, their decisions must be entered into the computer. After all the decisions are entered, the proctor calls the appropriate command procedure to submit the jobs. The output containing cost reports and river water quality is then distributed back to participants, normally on Monday. After the participants receive the feedback regarding the accuracy of their predictions about the game consequences of their decisions, they keep these reports so that they can analyze their future strategies. Game participants understand that their decisions lead to predictable results, and they will try to follow a systematic process that will enable them to achieve optimal outcomes. When those outcomes are used in discussions between the participants and the proctor, to analyze the adequacy of past performance and to gain clues for improving future performance, Fletcher [46] found that this improved participants' decision-making effectiveness in the game context.

The game session extended over a six-week period in the fall of 1985. the Natural Resource Economics class students only played the first four-period game which involved non-TDP cases. The remaining four periods were played by two professors and three graduate students. Each professor represented one industrial firm and one municipal plant, and each graduate student represented one industrial firm. The final result is based on these two different stages of decision-making.

Implementation of the TDP Market

A transferable Discharge Permit is not an effluent charge. Unlike the effluent charge, it does not purport to solve the problems of how much waste should be assimilated in water resources [47]. Rather, it assumes that some maximum loading has been selected and that the problem at hand is to find an efficient means for allocating that load among dischargers. Two major considerations in the allocating system are equity and efficiency. Some aspects of fairness are that each discharger should be allocated some share of the assimilative capacity of the stream, but that no discharger should have to bear an undue financial burden, and that dischargers do not make a sufficient effort to abate their pollution should not be entitled to a relatively larger share of TDP's than dischargers who do the cleanup. For the system to encourage efficiency, dischargers who can abate pollution relatively cheaply should do most of the required cleanup. TDP's provide a

mechanism for the exchange of pollution discharge units such that each discharger pays an equitable share of the costs of abatement, but only those dischargers who can abate pollution relatively cheaply are required to do the physical treatment.

The first step in establishing a TDP market is to allocate shares to the dischargers. The second step is to allow these permits to be transferred among dischargers. The quantity which can be bought and sold is fixed partly by the total loading and partly by the wastewater treatment requirements [48].

The foregoing suggest the following administrative framework for TDP's:

1. All point sources of wastewater would be required to hold TDP's equal to their permitted discharge. Table IV shows the initial holdings of permitted discharges for each discharger.

TABLE IV

	Maximum Permi	tted Discharge	
Team	Flow (MGD)	BOD (mg/l)	Permit (Lbs-BOD/day)
1	1.70	30	424.0
2	0.38	24	76.0
3	0.03	40	10.0
4	0.04	20	6.66
5	2.00	20	333.6
6	15.0	45	5629.5
7	3.0	10	250.2

INITIAL DISTRIBUTION OF TDP'S

2. Dischargers with an excess of TDP's would offer them for sale. Those with a deficiency would seek to purchase them. Exchange of TDP's would reallocate waste load so as to minimize the cost of attaining the desired water quality.

3. The penalty for exceeding the permitted discharge would be a fine sufficiently large to make the payment for TDP's preferable to the payment of fines.

Permit Durations

Permits can be issued with finite durations or in perpetuity. If permits are of short duration, the authority will presumably have more flexibility in altering the supply to adjust waster quality. Long-term permits, on the other hand, would allow dischargers to plan capital investment with less uncertainty and would allow improved cost efficiency in waste management.

The Market Mechanism

TDP market solutions are simulated by using engineering estimates of waste treatment costs. Other costs, such as transaction costs or administrative costs, are not taken into account. It is assumed that waste production levels and waste reduction costs will remain constant and that dischargers will trade permits as long as cost savings are possible. Their bids will reflect their marginal abatement costs since the dischargers will minimize the sum of the cost of the permits and of their treatment costs.

The combined usage of the "zero revenue auction" and the "incentive-compatible auction" were utilized to build a TDP market. At

the beginning of each period, each participant would receive an initial allocation of free permits; an incentive-compatible auction would then Incentive compatibility is defined as the property whereby be held. the mechanism encourages truthful revelation of information by each participant. As long as bidder collusion may be ruled out, an individual discharger's dominant strategy in such an auction is to reveal (bid) the true value of his TDP's. This would result in an efficient allocation of aggregate discharge. (In contrast, procedures that are not incentive-compatible may not always be efficient because bids may reflect discharger's strategies rather than the true value of TDP's.) The incentive-compatible auction is a part of the general class of preference revelation mechanisms investigated by Vickrey [49] and Clarke [50]. When homogenous (i.e., identical) TDP's are being allocated, the mechanism operates as follows: Bidders submit binding bid schedules to the authority, which then allocates permits to the highest bidders, as in the single-price auction. Instead of paying a uniform price for permits, however, a discharger winning k permits would pay the k highest rejected bids of all dischargers except himself. So, for example, if a discharger wins two permits, he would pay the two highest rejected bids for permits submitted by other dischargers. This procedure encourages bidders to always pay different prices for rights, instead of the uniform price as in the single-price auction [51, 52].

The incentive-compatible approach has the advantage, however, that it does not encourage strategic behavior by individual participants even where there are small numbers of them. Thus, the procedure is always efficient, even when the bidders have dissimilar beliefs. Such

dissimilarities may be important in real-world applications. Different dischargers, for example, may be expected to have different demands for TDP's based on their observable size or output characteristics. This is the reason why the incentive-compatible auction was used rather than the single-price auction because the TDP demand curve is non-continuous.

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The zero revenue auction has several attractive features. It is designed so that net revenue collection by the authority is zero. All the revenues from the auction are completely redistributed to the participants. Firms who reduce emissions relative to their initial allocations receive payments from firms who increase their emissions relative to their initial allocations. Thus, there is a net monetary transfer from polluters to abaters.

CHAPTER V

RESULTS AND DISCUSSIONS

Water Quality Analysis

One of the most important decisions the authority must make in designing any water quality management problem for a particular water body is to maintain the water quality standards. A water quality standard is assumed here to be expressed as the DO concentration and the BOD concentration. This research compares the water quality in a system with and without TDP's. A general hypothesis - water quality will deteriorate in the TDP system - was tested by using the Wilcoxon Ranks Test to consider performances of each team. For this evaluation the null hypothesis is defined as: there is no difference in water quality between the non-TDP system and TDP systems. Rank values can be calculated using the following relationship:

D = WQ(pe) - WQ(po)

Where D is difference

pe is pre-test (non-TDP case)

po is post-test (TDP case)

WQ is the water quality parameter

The results are analyzed at the location of all discharge points and at the sag point. Figure 4 indicates Teams 1 through 7 correspond to region elements 4, 8, 39, 18, 22, 14, and 30 respectively. The sag point is downstream element 45.

TABLE V

GENERAL WASTEWATER QUANTITY AND QUALITY PARAMETERS PRODUCTION WASTEWATER

Team	1	2	3	4	PE 5	RIOD 6	7	8
1 FLOW*	1.2	1.2	1.36	1.45	1.2	1.26	1.36	1.45
BOD**	200	200	200	200	200	200	200	200
2 FLOW	0.5	0.56	0.61	0.68	0.5	0.56	0.61	0.68
BOD	300	300	300	300	300	300	300	300
3 FLOW	0.04	0.05	0.06	0.06	0.04	0.05	0.06	0.06
BOD	400	400	400	400	400	400	400	400
4 FLOW	0.04	0.05	0.05	0.06	0.04	0.05	0.05	0.06
BOD	100	100	100	100	100	100	100	100
5 FLOW	2.00	2.04	2.08	2.12	2.00	2.04	2.08	2.12
BOD	400	400	400	400	400	400	400	400
6 FLOW	15.54	15.61	15.66	15.09	15.11	15.16	15.23	15.04
BOD	202.6	204.2	202.9	202.8	200.9	200.7	201.0	201.5
7 FLOW	5.04	5.08	5.13	5.18	3.0	3.04	3.08	3.12
BOD	171.3	220.2	139.7		200.0	202.4	205.1	207.6

*Flow is measured in MGD

**BOD is measured in mg/1

VII list the probabilities of significance and mean differences of DO concentrations and BOD concentrations for the eight system elements. Table VIII and IX list the stream quality parameters for periods 2 and 6 respectively.

TABLE VI

WILCOXON RANKS TEST RESULT IN DO CONCENTRATIONS (mg/1) AND PROBABILITY OF SIGNIFICANCE

System# Element	*Mean of Non-TDP System	**Mean of TDP System	Difference	Probability of Significance
4 (Team 1)	8.00	7.98	0.02	0.77
8 (Team 2)	7.97	7.78	0.19	0.56
14 (Team 6)	6.61	6.60	0.01	1.00
18 (Team 4)	8.75	8.72	0.03	0.56
22 (Team 5)	8.67	7.64	1.03	0.24
30 (Team 7)	7.93	7.81	0.12	0.66
39 (Team 3)	6.76	6.77	-0.01	0.88
45 (Sag Point	;) 6.68	6.67	0.01	0.77

*Non-TDP system, periods 1, 2, 3, and 4.

**TDP system, periods 5, 6, 7, and 8.

#See Figure 4

TABLE VII

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WILCOXON RANKS TEST RESULT IN BOD CONCENTRATIONS (mg/1) AND PROBABILITY OF SIGNIFICANCE

System# Element	*Mean of Non-TDP System	**Mean of TDP System	Difference	Probability of Significance
4 (Team 1)	18.82	19.69	-0.87	0.04
8 (Team 2)	16.96	17.84	-0.88	0.14
14 (Team 6)	26.69	24.81	1.88	0.08
18 (Team 4)	18.25	18.60	-0.35	0.24
22 (Team 5)	18.64	21.60	-2.96	0.02
30 (Team 7)	13.94	15.71	-1.77	0.04
39 (Team 3)	17.46	17.48	-0.02	1.00
45 (Sag Poir	nt) 15.20	15.22	-0.02	1.00

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*Non-TDP system, periods 1, 2, 3, and 4.

**TDP system, periods 5, 6, 7, and 8.

.

7

#See Figure 4

TABLE VIII

System#	Point Source		Stream Condition		
Element	Flow (MGD)	BOD (mg/1)	Flow (MGD)	DO (mg/1)	BOD (mg/1)
4 (Team 1)	1.26	30	17.86	6.64	18.13
8 (Team 2)	0.	0.	18.32	6.22	15.52
12	0.	0.	19.20	6.07	13.24
13	0.	0.	19.20	6.06	12.72
14 (Team 6)	15.61	45	34.81	5.32	26.51
18 (Team 4)	0.	0.	8.70	7.77	17.97
22 (Team 5)	0.	0.	10.31	7.63	18.20
30 (Team 7)	5.09	10	26.80	6.41	12.77
39 (Team 3)	0.	0.	64.12	4.77	15.72
45 (Sag Point)	0.	0.	65.49	4.70	12.83

STREAM QUALITY PARAMETERS FOR PERIOD 2

#See Figure 4

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TABLE IX

	Point S	ource	Str	Stream Condition			
System# Element	Flow (MGD)	BOD (mg/1)	Flow (MGD)	DO (mg/l)	BOD (mg/1)		
4 (Team 1)	1.26	*46	17.86	6.61	19.24		
8 (Team 2)	0.45	24	18.78	6.01	16.62		
12	0.	0.	19.70	5.91	14.17		
13	0.	0.	19.70	5.91	13.61		
14 (Team 6)	15.11	40	34.81	5.30	24.43		
18 (Team 4)	0.05	100	8.93	7.73	18.38		
22 (Team 5)	2.0	40	12.37	6.61	21.61		
30 (Team 7)	3.04	10	26.80	6.19	14.62		
39 (Team 3)	0.05	400	64.12	4.77	15.70		
45 (Sag Point)	0.	0.	65.49	4.70	12.81		

STREAM QUALITY PARAMETERS FOR PERIOD 6

*Treated wastewater flow rate is 1.08 MGD, BOD concentration is 20 mg/l.

Discharged waste flow rate is 0.18 MGD, BOD concentration is 200 mg/l.

Total wastewater flow is 1.26 MGD, Average BOD concentration is 46 mg/l.

#See Figure 4

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Water Cost Analysis

The relationship between effluent treatment cost and level of treatment achieved represents an essential element in evaluation of water quality pollution control policies. The objective of the wastewater treatment plant manager is to determine the minimum cost combination of treatment levels that meets a certain stream quality standard. Therefore, a purpose of this game is to see if it is possible to lower the financial burden on industrial firms and municipal plants without an adverse impact on the water quality standards.

This game uses the SAS package NPAR1WAY procedure to analyze TDP's impact on water quality related costs. The differences of the water quality related costs form a symmetric distribution. Therefore, Wilcoxon Ranks Test for significance can be utilized to measure and evaluate the differences between the water quality related costs under the TDP and non-TDP systems. The analysis is then performed on the average difference as a single sample observation. The samples are divided into groupings that represent each team and all teams (the whole region).

Table X indicates the water quality related cost for each team, Table XI presents the difference in water quality related costs for the paired comparisons, Table XII presents the Wilcoxon Ranks Test results, Table XIII presents the variable costs, Table XIV lists user charges for each team, and Table XV lists the transaction record for permits.

Based on the results shown in the tables, the following discussions are made:

TABLE X

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WATER QUALITY RELATED COSTS (\$)

Team	1	2	3	4	PERIOD 5	6	7	8
1	93818	95070	97067	99067	92307	93149	96517	98306
2	53606	47417	57493	62574	41632	44185	46310	49541
3	11067	11484	12080	12437	10887	11301	11889	12248
4	875 6	9013	9086	9342	8333	8579	8626	8879
5	209876	208586	217673	220115	154419	156689	159131	161573
6	6 69 018	664570	664473	662579	661786	662302	660634	658498
7	243885	253037	239783	238163	290995	28 969 0	288955	287498

TABLE XI

DIFFERENCE IN WATER QUALITY RELATED COSTS FOR PAIRED COMPARISONS (\$)

		D·	airs		
Team	WC (1)- WC (5)	WC (2)- WC (6)	WC (3)- WC (7)	WC (4)- WC (8)	AVERAGE
1	1511	1921	550	739	1178
2	11974	3232	11183	13033	9855
3	180	183	191	189	186
4	423	434	460	463	445
5	55457	51897	58542	58542	56109
6	7232	2268	3839	4081	4355
7	-47110	-36653	-49172	-49335	-45567

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TABLE XII

System Team	*Mean of Non-TDP System	**Mean of TDP System	Difference	Probability of Significance
1	96247	95069	1178	0.38
2	55272	45417	9855	0.04
3	11767	11581	186	0.56
4	9049	8604	445	0.04
5	214062	157953	56109	0.02
6	665160	660805	4355	0.02
7	243717	289284	-45567	0.02

WILCOXON RANKS TEST RESULT IN WATER QUALITY COSTS (\$) AND PROBABILITY OF SIGNIFICANCE

*Non-TDP System for periods 1, 2, 3, and 4.

**TDP System for periods 5, 6, 7, and 8.

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TABLE XIII

VARIABLE COSTS (\$)

					Period			
Team	1	2	3	4	5	6	7	8
1	31850	33102	35099	37067	25647	30040	34549	37033
2	11434	0	10247	12862	16430	16430	16430	16430
3	1604	1604	1604	1604	1604	1604	1604	1604
4	361	361	361	361	361	361	361	361
5	47629	48547	55192	55192	55127	55192	55192	55192
6	234872	236085	236414	237342	230902	231079	231746	232759
7	102926	110126	99387	100466	70939	71838	72828	73813

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TABLE	XTV	
INDLL	VIA	

USER CHARGES (\$)

	Period										
Team	1	2	3	4	5	6	7	8			
1	0	0	0	0	0	0	0	0			
2	19453	24697	24527	26993	2213	4780	6905	10136			
3	2382	2799	3395	3752	2382	0	0	0			
4	1464	1721	1794	2050	0	0	0	0			
5	77632	75425	77867	80309	0	2204	4646	7088			
ô	(21835)	(27497)	(27992)	(30745)	(4595)	(4780)	(6705)	(10136)			
7	(79097)	(77145)	(79660)	(82359)	0	(2204)	(4646)	(7088)			

*The numbers in parentheses indicate the revenue from user charges

TABLE XV

PERMIT TRANSACTION RECORD

		Number	of Permit	S		Permit	Costs (\$)
Per Tea	iod 5 m	6	7	8	5	6	7	8
1	260.7	64.2	0	*(39.1)	4693	1141	0	**(695)
2	14.2	14.2	14.2	14.2	270	256	256	256
3	*(10.0)	147.0	180.0	200.2	**(180)	2617	3204	3564
4	26.7	33	34.2	40.7	1041	1287	1334	1587
5	333.6	333.6	333.6	333.6	14678	14678	14678	14678
6	(625.5)	(592.0)	(570.34)	(558)	(20502)	(19979)	(20189)	(20107)
7	0	0	8.34	8.34	0	0	717	717

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*Parentheses indicate selling of permits. **Parentheses indicate revenue from selling permits.

The bidding permit price is lower for Team 1 than for other teams (details are given in Appendix I). Therefore, during periods 5 and 6, Team 1 can only buy the remaining available permits from the TDP market and can only discharge a portion of their wastewater to the river. Team 1's design BOD capacity is 20 mg/l and permitted BOD discharge concentration is 30 mg/l (Table I). Even though this team improves its treatment level of BOD to 20 mg/l in periods 5 and 6, the discharged waste flow to the river is increased with a BOD concentration of 200 mg/l (Table XVI). Therefore, the BOD loading to the river for periods

TABLE XVI

Develord	A 7 ±	Treated		Discharge	
Period	Alt.	Flow (MGD)	BOD (mg/l)	Flow (MGD)	BOD (mg/l)
1	1	1.2	30	0	0
2	1	1.26	30	0	0
3	1	1.36	30	0	0
4	1	1.45	30	0	0
5	7	0.88	20	0.32	200
6	7	1.08	20	0.18	200
7	1	1.36	37.6	0	0
8	1	1.45	30.4	0	0

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 1

5 and 6 is larger than that of the counterpart periods 1 and 2. In periods 7 and 8, as illustrated by the characteristics of the TDP system, the discharged BOD concentration can be slightly reduced. Therefore, the average BOD concentration under the TDP system is larger than that under the non-TDP system by 0.87 mg/l (Table VII), and the increased BOD loading results in decreasing DO concentration by 0.02 mg/l (Table VI).

The variable cost is a reflection of the treatment level, during periods 5 and 6, even though Team 1 uses its extra treatment capacity of 10 mg/l to lower its BOD effluent concentration to 20 mg/l, but since the treated wastewater flow is reduced (Table XVI), the variable cost for periods 5 and 6 is still less than that of the corresponding periods 1 and 2 (Table XIII), and the permit expense can not offset the variable cost saving. Therefore, the water guality related cost is reduced at periods 5 and 6 (Table XI). In period 7, since there are only a few remaining permits available in the TDP market, this team does not want to trade any permits. In period 7, the BOD effluent concentration is required to be 37.6 mg/l (calculation is given on page 29) to meet the discharge regulation. However, in period 3, in order to meet the water quality standard, the BOD effluent concentration has to be treated to 30 mg/l (Table XVI). The water quality related cost savings for paired period 7 is \$550, which means the free initial permit value is worth \$550 (Table XI). In period 8, since the unit treatment cost is lower than the permit market-clearing price for this team, it is a profitable option to sell permits. The policy for deciding the best strategy under the TDP system is given in Appendix B.

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Discharge point 2 is not far from discharge point 1, and the ratio of discharge flow is approximately 2% of the river flow near this point. Therefore, the stream water quality is slightly affected by this point source.

During periods 1, 2, 3, and 4, Team 2 allocates its pollution loading to municipal plant 6 by paying the user charge. During periods 5, 6, 7, and 8, the permit bid price for this team is higher than most teams in the TDP market (Appendix I), which means that this team can buy permits from the market and adjust to full capacity to obtain lower unit treatment costs. For this team, the trade-off is between difference of the variable cost, the user charge, and the permit expense. For instance, in period 7, the generated wastewater flowrate is 0.61MGD (Table XVII). The initial permit holding is 76 (Table IV). If this team wants to send all its wastewater to the municipal plant, it needs to pay a \$26,822 user charge. But, if this team wants to choose alternative 4, it needs to buy 14.2 permits to adjust its permit discharge capacity from 0.38 MGD to its full plant capacity 0.45 MGD (Table I) and pay \$6,905 (Table XIV) in user charges and \$16,430 (Table XIII) in variable costs. From these data, the permit price is \$38.67 and can be calculated using the following relationship:

Permit price = (difference in user charge + difference in

variable cost) / number of permits

During periods 2, Team 2 chooses alternative 3 without paying the variable cost (Table XIII). During periods 1, 3, and 4, this team chooses alternative 5 by paying both the variable costs and user

TAB	LE	X۷	II

Period	Alt.		Waste BOD (mg/l)	Send Waste to M Flow (MGD)	
1	5	0	0	0.35	250
				0.15	300
2	3	0	0	0.56	300
3	5	0	0	0.3	210
				0.31	300
4	5	0	0	0.40	210
				0.28	300
5	4	0.45	24	0.05	300
6	4	0.45	24	0.11	300
7	4	0.45	24	0.16	300
8	4	0.45	24	0.23	300

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 2

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charges (Table XIII, Table XIV). However, the difference in variable cost is much larger than that of the user charges. Therefore, this team does not choose the less expensive treatment alternatives during periods 1, 3, and 4. This can be illustrated by the significant reduction in the water quality related costs (Table XI) for the paired periods 2 and 6, compared to the remainder of paired periods. The average difference of water quality related cost savings for this team is \$9,855, and the probability of significance is less than 0.05 (Table XII). Obviously, this team is benefiting from the TDP system.

Team 3

The discharge at this point is less than 1% of the local river flow. Therefore, the stream water quality is slightly affected by this point source. Treated wastewater quantity and quality for Team 3 is shown in Table XVIII.

TABLE XVIII

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 3

Period	Alt.	Р	to Municipal lant BOD (mg/l)	Discharge Was River Flow (MGD) E	•
1	3	0.04	400	0	0
2	3	0.05	400	0	0
3	3	0.06	400	0	0
4	3	0.06	400	0	0
5	3	0.04	400	0	0
6	8	0	0	0.05	400
7	8	0	0	0.06	400
8	8	0	0	0.06	400

Team 3 represents a small plant, and generally a small plant is less efficient in treating wastewater. Therefore, under the non-TDP system, Team 3 always chooses alternative 3, "send all wastewater to the municipal palnt" under the non-TDP system. In period 5, the bidding permit price for this team is the second lowest in the TDP market (Appendix I). So this team sells 10 free initial permits (Table XV) to Team 1 and chooses alternative 3. The revenue for selling the permits is \$180 (Table XI). Again, this means that the free initial permits are worth \$180. The trade-off for this team is between the permit expense and the user charge. For periods 6, 7, and 8, the permit expense (Table XV) is less than the user charge of corresponding periods 2, 3 and 4 (Table XIV). Therefore, this team always chooses alternative 8, "discharge wastewater after buying permits".

Team 4

Team 4 is a small plant, and the unit treatment cost is higher than the user charge and the permit expense. Therefore, under the non-TDP system, this team always chooses alternative 3, "send all wastewater to the municipal plant 7" (Table XIX). Under the TDP system, this team always buys permits and chooses alternative 8, "discharge wastewater after buying permits".

The result of these alternatives is that under the TDP system, the BOD loading to the river increases at this point, however, the discharge from this point is very small, and the amount of impact on the water quality is not significant. The water quality related cost savings for this team comes from the difference between the user charge and the permit expense. The average cost savings is \$445, and the

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Period	Alt.		to Municipal lant BOD (mg/l)	Discharge Wa Rive Flow (MGD)	er
1	.3	0.04	100	0	0
2	3	0.05	100	0	0
3	3	0.05	100	0	0
4	3	0.06	100	0	0
5	8	0	0	0.04	100
6	8	0	0	0.05	100
7	8	0	0	0.05	100
8	8	0	0	0.06	100

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 4

probability of significance is 0.04 (Table XII), which means that the null hypothesis of two systems being equal is rejected.

Team 5

Team 5 is a large plant, and the unit treatment cost is lower compared to that of other plants. The design BOD effluent concentration is 40 mg/l and the maximum permitted discharge BOD concentration is 20 mg/l, which means that this team can not choose alternative 1 "treat wastewater in the company plant and release to the river", unless they upgrade the plant. Therefore, under the non-TDP system, this team allocates its wasteload to municipal plant 7. Under the TDP system, Team 5 buys 333.6 additional permits (Table XV), adjusts the permitted BOD effluent concentration to 20 mg/l, and chooses inexpensive treatment option 1 or 4 to treat its wastewater in its own plant (Table XX). Therefore, the BOD loading from this point discharge to the river is increased. According to the Wilcoxon Ranks Test, the probability of significance is approximately 0.02 (Table VII), which means the increased BOD loading is significant. The lower DO profile

TABLE XX

Period	Alt.	Treated Flow (MGD)			Municipal Plant BOD (mg/l)
1	5	0	0	1.8 0.2	100 400
2	5	0	0	2.0 0.04	250 400
3	5	0	0	2.0 0.08	40 400
4	5	0	0	2.0 0.12	40 400
5	1	2.0	40	0	0
6	4	2.0	40	0.04	400
7	4	2.0	40	0.08	400
8	4	2.0	40	0.12	400

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 5

downstream of this point is a consequence of a higher BOD loading under the TDP system. The mean differences for the DO concentration is 1.03 mg/l (Table VI) and for the BOD concentration is -2.96 mg/l (Table VII). Table XI indicates the average water quality related cost saving is \$56,109 for this team. Certainly this team benefits from using the TDP system.

Team 6

The structure of this game is to let the industrial firms discharge the wastewater to the municipal plant by paying the user charge. The major concern of the municipal plant managers is to bring the influent wastewater to the quality standard of the river authority. Under the non-TDP system, for the municipal plant, even though this plant has extra treatment capacity (the BOD permitted discharge concentration is 45 mg/l, and the design BOD effluent concentration is 40 mg/l), there is no strong incentive for reducing the BOD effluent concentration to 40 mg/l (Table XXI). Industrial firms under the non-TDP system are not allowed to buy permits and the only remaining feasible option is to send excess wastewater to the municipal plant, as illustrated in Table XXII, Team 2 and Team 3 allocate their wasteloads to this plant under the non-TDP system, this creates uncertainty about influent wastewater and the possibility of degrading water quality.

The purpose of TDP's is to facilitate exchange among treatment plants by compensating those who undertake a higher level of treatment in favor of those who don't. Under the TDP system, plant 6, by engaging in such treatment, receives revenue from selling permits and reduces the BOD effluent concentration to 40 mg/l (Table XXI).

TABLE XXI

eriod	Treated Flow (MGD)	Waste BOD (mg/l)
1	15.54	45
2	15.61	45
3	15.67	45
4	15.74	45
5	15.09	40
6	15.11	40
7	15.16	40
8	15.23	40

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 6

TABLE XXII

INFLUENT FLOWRATE (MGD) FOR MUNICIPAL PLANTS

		Period						
Team	1	2	3	4	5	6	7	8
2	0.50	0.56	0.61	0.68	0.05	0.11	0.16	0.23
3	0.04	0.05	0.06	0.06	0.04	0.04	0.	0.
6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Total for 6	15.54	15.61	15.67	15.74	15.09	15.11	15.16	15.23
4	0.04	0.05	0.05	0.06	0.	0.	0.	0.
5	2.00	2.04	2.08	2.12	0.	0.04	0.08	0.12
7	3	3	3	3	3	3	3	3
Total for 7	5.04	5.09	5.13	5.18	3	3.04	3.08	3.12

These phenomena reflect in the cost analysis: Under the non-TDP system, the major income is user fees (Table XIV). Under the TDP system, the major revenue is from selling permits (Table XV). For Team 6, the average water quality related cost savings is \$4,355 which is approximately 0.7% of the total water quality related cost (Table XXIV).

Team 7

Under the TDP system, plant 7 receives a relatively small amount of wastewater from plants 4 and 5 (Table XXIII). Under the non-TDP system, plant 7 receives a relatively large amount of wastewater from plants 4 and 5, causing the increased discharge from this point to the river (Table XXIII). However, the BOD effluent concentration from this point source is 10 mg/l, which is lower than that of the point source

TABLE XXIII

TREATED WASTEWATER QUANTITY AND QUALITY FOR TEAM 7

Period	Treated Waste Flow (MGD) BOD (mg/l)		
1	5.04	10	
2	5.09	10	
3	5.13	10	
4	5.18	10	
5	3.00	10	
5 6	3.04	10	
7	3.08	10	
8	3.12	10	

of Team 4 (Table XIX) and Team 5 (Table XX). Plant 7 is located downstream from the discharge points of plant 4 and plant 5. The aggregated discharge from plant 4, plant 5, and plant 7 are equal at this point. Therefore, the increased discharge from this point results in a decreased BOD concentration in the river under the non-TDP system. The general rule is that the lower the BOD concentration, the higher the DO concentration. Considering these two systems, under the non-TDP system, the larger discharge from this point results in a lower BOD concentration and a higher DO concentration. These phenomena reflect in the water quality analysis: In period 2 (non-TDP system) the stream DO concentration is 6.41 mg/l and BOD concentration is 12.77 mg/l (Table VIII). In period 6 (TDP system), the stream DO concentration is 6.19 mg/l and BOD concentration is 14.62 mg/l (Table IX). The mean differences for the DO concentration and BOD concentration of these two systems are 0.12 mg/l (Table VI) and -1.77 mg/l (Table VII) respectively.

During periods 1, 2, 3, and 4, the influent wastewater from plants 4 and 5 is approximately 40% of the influent residential wastewater to plant 7. During periods 5, 6, 7, and 8, the influent wastewater from plants 4 and 5 is approximately 2% of the influent residential wastewater to this plant (Table XXII). These effects reflect in the cost analysis report: Under the non-TDP system, the average user charge is \$79,000, but in the TDP system the average user charge drops to \$4,000 (Table XIV), which means the uncertainty of influent wastewater quality and quantity can be minimized.

Team 7 does not have extra treatment capacity for incoming industrial wastewater. (The permitted discharge BOD concentration is 10 mg/l, and design BOD effluent concentration is 10 mg/l). In order

to meet the water quality, this team needs to buy additional permits for an external wasteload (Table XV). Under the non-TDP system, the water quality related cost is subsidized by the user fees. But under the TDP system, this team only receives a small amount from the user fees and the drop in the user fees is greater than the drop in the variable costs (Table XIII). Even though this team has extra flow capacity (the permitted discharge capacity is 3.0 MGD, and design flow capacity is 5.5 MGD), it can not use its extra flow capacity, since the TDP's are distributed on the basis of permitted standards. Therefore, Team 7 is the only team losing under the TDP system (Table XI).

Sag Point

In this simulation game, the critical DO point occurs at element 45 (Figure 4). For the DO concentration, the average concentration is 6.68 mg/l before the TDP scheme. After implementing the TDP system, the average concentration is 6.67 mg/l. the probability of significance in this case is approxiamtely 0.77 (Table VI); the null hypothesis can be accepted, and there is no significant difference between these two systems.

Water Quality Impact for the Whole Region

When the Wilcoxon Ranks Test is analyzed in terms of the BOD concentration, only seven elements (elements 22, 23, 24, 25, 26, 27, and 30) show less than 0.05 significant probabilities. In terms of DO concentration, there is no significant effect on these elements. The conclusion is that the null hypothesis is accepted and the environmental impact of discharge is identical before and after the TDP system.

Cost Efficiency for the Whole Region

The cost efficiency of a particular program is measured by the aggregate economic cost of achieving the water quality standard. Only the costs of real resources are considered in calculating the aggregate cost. The payments for discharge should not be included because these payments are transferred between parties.

Table XXIV lists the water quality related cost savings for each team. The total cost savings for all the teams is \$26,561 per quarter and approximately \$106,000 per year. Table XII, the Wilcoxon Ranks Test results, shows the probability of significance for Teams 2, 4, 5, and 6 is less than 0.05, i.e., four out of seven teams benefit from the TDP system.

TABLE XXIV

System Team	*Mean of Non-TDP System	**Mean of TDP System	Difference	Ratio
1	96,247	95,069	1,178	1.2%
2	55,272	45,417	9,855	17.8%
3	11,767	11,581	186	1.5%
4	9,049	8,604	445	4.9%
5	214,062	157,953	56,109	26.2%
6	665,160	660,805	4,355	0.7%
7	243,717	289,284	-45,567	-18.7%
Total Cost	Saving		26,561	

WATER QUALITY RELATED COST SAVING (\$)

*Non-TDP system, periods 1, 2, 3, and 4. **TDP system, periods 5, 6, 7, and 8.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The analyzed results indicate that the TDP system is cost efficient. Using the TDP system would result in a total annual savings of approximately \$106,000. The average DO concentration at the sag point however, is decreased slightly. Transferable permits are important because the total costs of attaining water quality standards are lower with transfers.

After implementing the TDP system, the whole region will have water quality related cost savings without an adverse effect on water quality. Also, four teams benefit from the TDP system, and the reasons can be attributed to: (1) Incentive-compatible auctions, (2) Plants have different alternatives for controlling effluent, and (3) Free initial distribution of permits.

Team 7 is the only team that bears an undue financial burden under the TDP system. For this team, the design capacity is 5.5 MGD, but the permitted discharge capacity is 3.0 MGD (Table I). Since the TDP's are distributed on the basis of permitted standards, this team can not use its extra capacity in terms of flow. A reasonable approach to the permit distribution should be considered in terms of both the permitted standards and design capacity.

Transferable discharge permits would result in higher actual (in contrasted to permitted) wasteloads. Dischargers who, for example, expand their production and find their waste treatment capacity inadequate can acquire permission to discharge from those with excess treatment capacity. With such offsets, water quality standards continue to be met, but the level of actual discharge to the watercourse is closer to the water quality limits.

BOD is an important representative of the category of water pollutants that degrade once discharged. In such cases the location of discharges affects water quality (dissolved oxygen in the BOD case) at a given location. Also, because physical parameters typically vary throughout a watercourse, a change in the location of a discharge usually not only shifts the location of impact, but it also affects the degree of impact. But in this dissertation, the transfer coefficient for each permit is the same for allowing one-to-one trades of permits, however the effect of discharges on water quality is different for different discharge locations. Therefore, it is better to formulate the effluent permits by impact coefficients. If the goal is to achieve a given level of dissolved oxygen concentration, the impact coefficients can be generated by simulating a series of DO levels associated with increased individual effluent loadings and calculating the changes in the DO at the sag points. Sensitivity analysis may confirm the accuracy of using linear approximations to define the effluent/water quality relationship at different combinations of stream flow and stream temperature. In this way, the number of permits issued by an authority would depend on the desired water quality. To account for the differential impact of different polluters on the water quality,

permits will be worth different amounts to different polluters.

Time variability in the assimilative capabilities of the environment and in demands for the waste disposal services of the environment have long posed problems for pollution control systems. Streamflows vary and atmospheric conditions change over both long and short periods, requiring variations in TDP's if water quality standards are not to be violated. This research does not deal with this problem and assumes the river flow is constant for the entire period. To avoid violating real-world facts, a "priority rights" system for allocating available assimilative capacity should be established. In the case of surface water, the functioning of a priority system depends on the probability distribution of streamflows: More senior rights have a higher probability of getting their streamflow to assimilate waste than do more junior rights.

To help ensure the continued maintenance of water quality, market restrictions may be added to prevent or discourage transfers of permits that would cause violations. Since water quality problems depend in part on local physical features, the type of trading restrictions chosen by policymakers would be expected to vary from one water body to another. One way to restrict transfers is to define permits so that they can be exercised in only a certain zone in a waterway. This mechanism can allow equal opportunities for dischargers within a given zone to purchase BOD permits (This research assumes seven teams are located within one zone). Between-zone inequities could still be perceived, however, depending on the characteristics of the dischargers and of the physical river system under study.

Recommendations

Future research work should be continued in the TDP system in several areas:

 Transferable discharge permits should be formulated by impact coefficients. The nature of the impact is modified by - temperature and flow - which affect the assimilative capacity of the stream.

2. Transferable discharge permit distribution should be considered in terms of both the permitted standards and discharge capacity.

3. Priority rights can increase the adaptability of the TDP system to short-term fluctuations in the assimilative capacity of the environment. They should be combined with the TDP system.

4. The definition base of permits should not be restricted by only BOD and DO. Nitrogen, phosphate, and heavy metals seem to be candidates for the basis of definition of permits.

5. Unrestricted transfers of BOD permits could cause violations of the water quality standard. Restricting transfers of permits to geographical zones could be used to reduce or possibly prevent violations of a standard.

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APPENDICES

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APPENDIX A

CASE STUDY INDUSTRIAL DISCHARGE NO. 1

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Synopsis

You are the water guality manager for the Sunbelt Cotton Company. This company is a major producer of cotton fiber products and is located along the Paladine River. The area has experienced a lot of growth in the last 50 years, with a resultant decrease in stream water The State Water Resources Board, as mandated by the quality. Environmental Protection Agency, has established standards or waste load allocations for each discharger along the river. You have a number of alternatives for complying with the waste load allocations. These alternatives are: (I) Treat all wastewater in the company plant and release to the river; (II) Pretreat all wastewater in the company plant and send to the municipal treatment plant; (III) Send all wastewater to the municipal treatment plant without treatment; (IV) Treat part of the wastewater in the company plant and release, send the other part of the wastewater, without treatment, to the municipal plant; (V) Pretreat part of the wastewater in the company plant and send to the municipal plant, send the other part of the wastewater, without treatment, to the municipal treatment plant: (VI) Discharge all wastewater without permit and without treatment; (VII) Treat part of the waste in the company and release it to the river, send the other part, without treatment, to the river; (VIII) Discharge wastewater after buying permit. If the cost of treatment outweigh the marginal profits, you might recommend reducing the production levels. You might also decide to upgrade the plant. Your task is to determine the best

alternative for disposing of the current period's waste and decide if any upgrades of the plant should be made.

Description of the Company

The Sunbelt Cotton Company is a large producer of cotton fiber products. Sunbelt's products are sold in a national market with the company having a 9% share of the market. However, the market is very competitive. The company cannot increase prices without a reduction in demand. Also, price promotions are usually copied by competitors as well.

The company was founded by the Simpson family. This family was among the first families to settle in Paladine City and thus chose to locate the plant close to the local river, the Paladine River, so that most of the effluent of the plant could simply be released into the river. This was an effective and inexpensive way to dispose of the waste of the plant. The flow of the river was sufficient to carry all the waste that was generated. The city had a treatment plant which was able to treat the biological waste efficiently. The river water quality was acceptable for body contact recreation and for aquatic life.

As the years went by, other companies located in the area. The city also experienced a lot of growth. Since the founding family, the Simpsons, was very conscientious about the river water quality, they installed a treatment plant in the company to treat the waste. The plant was installed in 1976, the same year the Simpsons sold the company to a national concern. The plant has not been upgraded since then even though the company has continued to experience a rapid

growth. The parent company viewed the treatment plant as an unnecessary overhead.

As the quality of discharge from Sunbelt deteriorated and the city and other companies grew in size, there was a noticeable decline in the water quality of the Paladine River. One other factor in this decline was a new major reservoir upstream which resulted in frequent low flow conditions.

A number of letters to the editor in the local papers was followed by protests to the Water Resources Board from the citizens of Jonesville, a city located 15 miles downstream. The first task of the board was to establish the effect of existing effluent loads on the water quality. An acceptable total waste load was then deduced from the desired water quality target. This total waste load was then allocated among the different dischargers along the river. This was accomplished by allocating to each discharger a claim on the receiving stream's capacity to assimilate waste, which is called a "waste load allocation". These waste load allocations are developed in terms of Biochemical Oxygen Demand (BOD) and its corresponding water quality parameter, Dissolved Oxygen (DO). The waste load allocation is used as the basis for permit limits for each discharger. (Water quality is measured only in terms of BOD levels. While this is a narrow view of the quality of water, this simplification permits us to concentrate on other economic issues.)

You have been hired by Sunbelt to manage its effluent treatment program and are thus responsible for making decisions for treating the company's wastewater. You report directly to the vice president of operations. While you are not directly involved in the production

decisions, the V.P. has assured you that your inputs will be given high consideration in making final decisions on production levels.

Production Function

The conversion of cotton fiber into a finished product involves a number of different operations. The cotton is received in bales which are opened and cleaned by machines which blend the cotton while removing a great deal of loose dirt. The cotton is then rolled into sheets ready for the carding and spinning operations. The carding operation combs the cotton, aligning the fibers in parallel prior to spinning them into yarn. Before the yarn can be woven into fabric, it must be strengthened. This is done in an operation known as slashing. The purpose of slashing is to stiffen the fiber by loading it with starch and with other substances called sizing. The sized yarn is then woven into the fabric, brushed, singed and inspected. Finally, the fabric is put through dyeing and finishing operations.

The marketing, finance, and operations departments have developed the final forecasts of production over the next year. The total fabric processed (in millions of pounds) is expected to be as shown in Table A-1.

Even though production fluctuates from quarter to quarter the company tries to maintain the same payroll. The company has been reasonably profitable to date. A simplified earnings statement indicates that the company can sell its output at \$1,200,000 per million pounds of fabric produced. Cost of goods sold is about 60% of sales revenue, exclusive of waste treatment costs. Other expenses are about 10% of sales revenue. The company has a healthy balance sheet. It has very little debt and a \$15 million line of credit which is mostly used

TABLE A-1

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Millions Of Pounds Of Fabric	2.475	2.600	2.800	3.000
Discharge (MGD)	1.200	1.260	1.360	1.460
BOD (mg/l)	200	200	200	200

PRODUCTION AND EFFLUENT FORECAST

to finance the purchase of cotton. Last year, the company earned about \$1.8 million on sales of about \$12 million.

Effluents

The cotton processing plant in the company has state-of-the-art equipment. However, a large amount of biological waste is generated. The waste is a function of the production volume. The wastewater flow rate is 32,000 gallons of water per 1,000 pounds of output produced and the BOD concentration is 200 mg/l. Based on historical analysis, you have determined that the wastewater discharges and BOD levels in Table A-1 would result if planned production was realized. (Other BOD discharge for any other production levels can be determined by using the participant input program.)

Effluent Removal Strategies

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At the present time, Sunbelt's water quality standard has been set at a BOD concentration of 30 mg/l and wastewater flow of 1.7 MGD. The company's wastewater treatment plant has a wastewater design flow rate of 1.5 MGD and a BOD concentration design level of 20 mg/l.

The options available for complying with the waste load allocations established by Water Resources are:

Alternative 1: Alternative 1 involves "Treat all wastewater in the company plant and release to the river". This alternative is subjected to a number of restrictions; (a) Treated wastewater flow rate should not exceed the plant's design capacity, (b) The treated wastewater flow rate should not exceed the maximum limitation of wastewater flow rate established by the Water Resources Board, (c) The treated wastewater BOD effluent concentration should not exceed the plant's design BOD effluent concentration, (d) The treated wastewater BOD effluent concentration hould not exceed the allowed BOD effluent concentration to the river set by the Water Resources Board, (e) The plant's design BOD effluent concentration should not be larger than the allowed BOD effluent concentration to the river. For the TDP case, this restriction will be released.

Alternative 2: The second alternative states "Pretreat all wastewater in the company plant and send to the municipal treatment plant." This alternative will be subjected to the following (a) Pretreated wastewater flow rate should not exceed restrictions: the (b) Pretreated wastewater BOD effluent desian capacity, concentration should not exceed the design BOD effluent concentration,

and (c) Pretreated wastewater BOD effluent concentration should not exceed the allowed BOD effluent concentration to the municipal treatment plant.

Alternative 3: The third alternative states "Send all wastewater to the municipal treatment plant without treatment". This alternative will be restricted by BOD effluent concentration of discharged wastewater, which should not exceed the allowed BOD effluent concentration to the municipal treatment plant.

Alternative 4: The fourth alternativew states "Treat part of the wastewater in the company plant and release; send the other part of the wastewater, without treatment, to the municipal plant". This alternative will be restricted by seven factors: (a) Treated wastewater flow rate should not exceed the production wastewater flow rate, (b) Treated wastewater flow rate should not exceed the plant's design capacity, (c) Treated wastewater should not exceed the maximum limitation of wastewater flow rate to the river, (d) Treated wastewater BOD effluent concentration should not exceed the design BOD effluent concentration, (e) Treated wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the river, (f) Discharged wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the municipal treatment plant, and (q) The design BOD effluent concentration should not be larger than the allowed BOD effluent concentration to the river (for TDP case, this restriction is cancelled).

Alternative 5: The fifth alternative states "Pretreat part of the wastewater in the company plant and send to the municipal treatment; send the other part of the wastewater, without treatment, to the

municipal treatment plant". This alternative will be restricted by four factors: (a) Pretreated wastewater flow rate should not exceed the production wastewater flow rate, (b) Pretreated wastewater quantity should not exceed the design capacity, (c) Pretreated wastewater BOD effluent concentration should not exceed the design capacity for BOD effluent concentration, and (d) Pretreated and discharged wastewater BOD effluent concentration should not exceed allowed BOD effluent concentration to the municipal treatment plant.

Alternative 6: The sixth alternative says "Discharge all wastewater without permit and without treatment". This alternative does not have any restrictions.

Alternative 7: The seventh alternative states "Treat part of the wastewater in the company plant and release; send the other part, without treatment, to the river". This alternative will be restricted by three factors: (a) Treated wastewater flow rate should not exceed the production wastewater flow rate, (b) Treated wastewater flow rate should not exceed the plant's design capacity, (c) The discharge permitted is equal to the initial permit holdings plus traded permits.

Alternative 8: The eighth alternative says "Discharge wastewater after buying permit". This alternative will be restricted by the fact that the discharge permit needed is equal to the initial permit holding plus buying permit numbers (for TDP case only).

Upgrade Plan: Should your production forecasts indicate that you will not have enough capacity in your company's treatment plant and you decide to treat the waste in your plant, you might decide to upgrade your plant capacity. The upgrade plant is restricted by the following: (a) The future design capacity is not less than the current design

capacity, and (b) The future design BOD effluent concentration is not more than the current design BOD effluent concentration (i.e., quality of treated waste should not be worse than the current quality of the effluent).

If the costs of treatment outweigh the marginal profits, you might recommend reducing the production levels. It is assumed in the statement of these alternatives that it is not feasible for Sunbelt to install new cotton processing technology.

The selection of any one of the options listed above will involve several types of costs. These include capital or fixed costs, variable costs, and municipal user charges. (Fixed costs will always be greater than zero regardless of your decision for handing the company's waste.) These costs vary with the wastewater design flow rate and the BOD design effluent concentration. As stated above, the wastewater design flow rate for Sunbelt's treatment plant is 1.5 MGD and the design BOD effluent concentration is 20 mg/l. For this plant, the annual fixed costs are \$61,968.00.

The variable costs are shown in Table A-2. For a given BOD capacity design removal rate, variable costs vary with the actual BOD treatment level and the actual waste flow rate.

The transfer of any amount of waste to the municipal treatment plant involves the payment of a user charge to the municipal treatment plant. The size of this charge will vary with the volume of wastewater flow and the concentration of BOD if it is greater than 250 mg/l. A schedule of user charges for Sunbelt is shown in Table A-3.

VARIABLE COSTS (\$)

Wastewater		Effluent Conc	entration (mg,	
(MGD)	160	140	40	20
1.1	\$26,447	\$26,695	\$29,142	\$30,591
1.2	28,329	28,595	31,215	32,767
1.3	30,178	30,461	33,253	34,906
1.4	31,997	32,298	35,258	37,011
1.5	33,790	34,107	37,233	39,084
1.6	35,557	35,891	39,181	41,129
1.7	37,302	37,652	41,103	43,146
1.8	39,024	39,391	43,001	45,139
1.9	40,727	41,110	44,878	47,109
2.0	42,412	42,810	46,734	49,057

In certain cases you may decide to expand and/or upgrade the existing treatment facilities. This decision involves additional capital costs. The annual fixed capital costs for a number of upgraded plants are shown in Table A-4. These costs will vary with the wastewater design flow and with the BOD design removal rate. Once the waste treatment facility capcity is defined in terms of the wastewater design flow and the BOD capacity design removal rate, the capital costs become fixed costs until further decisions are made to again augment the treatment plant. The operation of the plant in this case will

MUNICIPAL USER CHARGES (\$)

Wastewater (MGD)	8 200	OD Effluent Cond 140	centration (mg 120	/1) 100
1.0	\$36,610	\$36,610	\$36,610	\$36,610
1.1	40,271	40,271	40,271	40,271
1.2	43,932	43,932	43,932	43,932
1.3	47,593	47,593	47,593	47,593
1.4	51,255	51,255	51,255	51,255
1.5	54,915	54,915	54,915	54,915
1.6	58,577	58,577	58,577	58,577
1.7	62,238	62,238	62,238	62,238
1.8	65,899	65,899	65,899	65,899
1.9	69,560	69,560	69,560	69,560
2.0	73,221	73,221	73,221	73,221

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TABLE A-4

CAPITAL COSTS (\$)

Design Wastewater (MGD)	Design BOD Effluent (20	Concentration (mg/l) 10
1.5	\$61,968	\$69,235
1.7	69,269	77,394
1.8	72,884	81,433
2.0	80,050	89,438
2.1	83,603	93,408
2.2	87,137	97,387
2.3	90,653	101,280

involve variable costs which will increase nonlinearly with changes in the actual BOD effluent concentration level and the actual wastewater flow rate. The additions to the plant will not become available for actual use until two periods after the decision to upgrade and/or add to the plant has been made. APPENDIX B

EXAMPLE OF WASTE DISPOSAL DECISIONS FOR CASE STUDIES

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Decisions Without TDP

Team 1: Cotton Processing Plant

Production Forecast = 2.475 million pounds of product

Discharge = 1.200 MGD

BOD Concentration = 200 mg/1

Water Quality Standard

Discharge = 1.70 MGD

BOD Concentration = 30 mg/1

Treatment Plant Design Capacity

Discharge = 1.50 MGD

BOD Concentration = 20 mg/1

Viable Alternatives for Disposing of Waste

Could use one of the following alternatives:

- A) Alternative 1
- B) Alternative 2
- C) Alternative 3
- D) Alternative 4
- E) Alternative 5

Costs of the Different Alternatives

Note: All of the different alternatives have the same capital or fixed cost which is \$61,968 (illustrated in Table B-3).

A) Cost of alternative 1: Treat all wastewater in the company

plant and release to the river. This alternative would require payment of variable cost for operation of the treatment plant. The amount of waste to be treated in the company plant and released cannot exceed the standard of a BOD concentration equal to 30 mg/l and wastewater flow equal to 1.70 MGD.

The variable cost for a treatment plant treating 1.2 MGD wastewater with a BOD effluent concentration of 30 mg/l can be calculated from Table B-1 by extrapolation.

Using Table B-1, look at the row of wastewater flow for 1.2 MGD and the columns of BOD effluent concentration of 40 mg/l and 20 mg/l.

If the BOD concentration is 40 mg/l and the treated wastewater flow is 1.2 MGD, the variable cost is \$31,497.

If the BOD concentration is 20 mg/l and the treated wastewater flow is 1.2 MGD, the variable cost is \$32,767. Find the approximate charge for a BOD effluent concentration by extrapolating as follows:

1) Let X1 = lower BOD effluent concentration. Let X2 = upper BOD effluent concentration. Let Xa = actual BOD effluent concentration. P = proportionality factor Calculate P as follows: P = (xa - x1)/(x2 - x1) For this example, X1 = 20, X2 = 40, Xa = 30. P = (30 - 20)/(40 - 20) = 0.50.

2) Let C1 = Variable cost associated with X1.

VARIABLE COSTS (\$)

Wastewater	BOD	Effluent Conce	entration (mg/)
(MGD)	160	140	40	20
1.1	\$26,447	\$26,695	\$29,142	\$30,591
1.2	28,329	28,595	31,497	32,767
1.3	. 30,178	30,461	32,253	34,906
1.4	31,997	32,298	35 , 258	37,011
1.5	33,790	34,107	37,233	39,084
1.6	35,557	35,891	39,181	41,129
1.7	37,302	37,652	41,103	43,146

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Let C2 = Variable cost associated with X2.

Let D = Difference in variable cost.

D = C2 - C1

For this example, C1 = 31,497 and C2 = 32,767.

From Table B-1:

D = 32,767 - 31,497 = 1,270

3) Let I = Proportionality cost.

For this example, I = (0.50) (1,270) = 635

4) Let Ce = estimated variable cost

Ce = C1 + I

Ce for this example:

Ce = 31,497 + 635 = 32,132
```

The total cost of alternative 3 is as follows: Fixed Cost = \$61,968 Variable Cost = \$32,132 Total Cost = \$94,100.

B) Cost of alternative 2: Pretreat all wastewater in the company plant and send to the municipal plant. This alternative would require payment of a municipal user charge as well as incurring variable cost for operating the treatment plant.

Since the generated BOD concentration is 200 mg/l, the municipal user charge will be the same as that of alternative 3.

Therefore, total cost of alternative 2 will always be more expensive than that of alternative 3.

C) Cost of alternative 3: Send all waste to the municipal plant without treatment.

This alternative would require payment of a municipal user charge.

Waste flow parameters are as follows:

BOD concentration = 200 mg/1

Discharge flow = 1.2 MGD.

The municipal user charge can be found from Table B-2. Using Table B-2, and the column for 100 mg/l and the row of wastewater flow for 1.2 MGD; the user charge is \$43,932.

Fixed Cost = \$61,968

Municipal User Charge = \$43,932

Total Cost = \$105,900.

TABLE B-2

Wastewater (MGD)	200	BOD Effluent Cor 140	ncentration (mg 120	/1) 100
1.0	\$36,610	\$36,610	\$36,610	\$36,610
1.1	40,271	40,271	40,271	40,271
1.2	43,932	43,932	43,932	43,932
1.3	47,593	47,593	47,593	47,593
1.4	51,255	51,255	51,255	51,255
1.5	54,915	54,915	54,915	54,915

MUNICIPAL USER CHARGES (\$)

- D) Cost of alternative 4: Treat part of the wastewater in the company plant and release; send the other part of the wastewater, without treatment, to the municipal plant.
- E) Cost of alternative 5: Pretreat part of the wastewater in the company plant and send to the municipal plant; send the other part of the wastewater, without treatment, to the municipal plant.

These alternatives would require payment of a municipal user charge as well as incurring a variable cost for operating the treatment plant.

Since the municipal user charge is more expensive than the variable cost, no matter what proportion of wastewater is treated in the company plant, the total cost will always be greater than alternative 1.

Based on these calculations, the best alternative for Team 1 is alternative 1.

TABLE B-3

CAPITAL COSTS (\$)

Design Wastewater (MGD)	Design BOD Effl 20	uent Concentration (mg/l) 10
1.5	\$61,968	\$69,235
1.7	69,269	77,394
1.8	72,884	81,433
2.0	80,050	89,438
2.1	83,603	93,408

Example of Waste Disposal Decisions with TDP's Determination of Bid/Ask Price for a TDP

Again, consider Team 1. One permit entitles the holder to discharge one Lb. of BOD per day for one quarter.

 $Lbs-BOD/day = (mg/1) \times (MGD) \times 8.34 \ lbs/[(mg/1) \times (MG)]$

Each discharger is given an initial number of permits to coincide with its stated wasteload allocation.

In this example, BOD Lbs/day is as follows:

Lbs-BOD/day = (30 mg/l) x (1.70 MGD) x (8.34 Lbs/[(mg/l) x (MG)])

For this example, the discharger is allowed to emit 424 Lbs of BOD per day for one quarter.

Discharger now has 424 permits.

The Decision to Buy or Sell Permits

When break-even analysis is used to determine the bidding permit price, the logical boundaries for when to buy and sell permits must be considered.

The decision to buy or sell TDP's entails a comparison of the internal estimated cost of removal of waste at the local plant and the cost of TDP's. If TDP's are less costly than local treatment, TDP's will be purchased and local treatment will not be undertaken.

If alternative 8, "Discharge wastewater after buying permits" is chosen, 1577 permits are needed, and the cost of this option would be the permit buying cost.

The revenues from buying the permits could be used to offset the variable cost.

Additional permits needed are equal to

 $(1.2 \times 200 \times 8.34) - 424 = 1577.$

If alternative 1, "Treat wastewater in the company plant and release it to the river" is selected, 1.2 MGD wastewater is treated to BOD effluent concentration 20 mg/1.

The number of permits to be sold in alternative 1 is based on the difference between the treatment plant capacity and the permitted discharge standard.

Fixed Cost = \$61,968

Variable Cost = \$32,767

Surplus Permit Sold = 424 - (1.2 x 20 x 8.34) = 224

Using break-even analysis:

32767 - 224 x unit permit price = 1577 x unit permit price.

Unit Permit Price = \$18.19.

This means that if the TDP market price is less than 18.19, and if Team 1 decides to choose alternative 8, Team 1 will buy 1577 permits, at most. On the contrary, if the TDP market price is more expensive than 18.19, and if Team 1 decides to select alternative 1, Team 1 will sell 224 permits, at most.

How to Decide Market Price for Permit

The market model is based on the multiple-price auction, negotiation between bidders, and rational bidder behavior. The following table is obtained from Appendix I.

Team	<pre># of permit</pre>	buying	<pre># of permit</pre>	selling
	bought	Price	sold	price
1	<-1577	<-18.19	<-224	18.19->
2	<-14.2	<-38.67	<-76	38.67->
3	<-123	<-17.8	<-10	17.8->
4	<-26.66	<-43.88	<-6.66	43.88->
5	<-333.6	<-95.8	<-333.6	95.8->
6			<-625.5	5.0->
7				

Based on the above information, the administration decides to make the following trading transactions: Team 1 will buy 10.0 permits at \$18 from Team 3 Team 1 will buy 250.7 permits at \$18 from Team 6 Team 2 will buy 14.2 permits at \$19 from Team 6 Team 3 will sell 10.0 permits at \$18 to Team 1 Team 4 will buy 26.7 permits at \$39 from Team 6 Team 5 will buy 333.6 permits at \$44 from Team 6 Team 6 will sell 250.7 permits at \$18 to Team 1 Team 6 will sell 14.2 permits at \$19 to Team 2 Team 6 will sell 26.7 permits at \$39 to Team 4 Team 6 will sell 26.7 permits at \$39 to Team 4

Best Strategy With TDP Case

Current permit holding = 424 + 260.7 = 684.7

Design flow rate = 1.5 MGD

Actual flow rate = 1.2 MGD

Design BOD effluent concentration = 20 mg/l

Expected BOD influent concentration = 200 mg/1

Apparently, alternative 7, "Treat part of the wastewater in the company plant and release; send the other part, without treatment, to the river", will be a less expensive alternative.

Assumption: Y is the discharged flow rate (200 x Y x 8.34) + (1.2 - Y) x 20 x 8.34 = 684.7

Y = 0.32 MGD

Therefore, the best alternative for Team 1 is to treat 0.88 MGD wastewater from BOD 200 mg/l influent concentration to 20 mg/l effluent concentration, and discharge 0.32 MGD to the river.

APPENDIX C

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COMMAND PROCEDURE TO SPECIFY DATASETS AND SUBMIT THE COST PROGRAM AND THE QL2SMG PACKAGE

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**** TSO FOREGROUND HARDCOPY ****
DSNAME=U11502C.TEACHERA.CLIST
00000100CONTROL MSG
00000200FREEALL
00000300WRITE THIS PROGRAM WILL TAKE YOUR INPUT FOR THE WATER QUALITY
00000400WRITE SIMULATION GAME AND GENERATE THE OUTPUT FILE
00000500WRITE
00000600WRITE ENTER PERIOD NUMBER (E.G. 1)
00000700READ &PERIOD
00000800WRITE ENTER PASSWORD
00000900READ & PASSWORD
00001000ATTRIB TEMP BLKSIZE(6160) LRECL(80) RECFM(F B)
00001100ALLOC F(FT15F001) DS(DECISION.DATA(A1&PERIOD)) SHR
00001200ALLOC F(FT16F001) DS(DECISION.DATA(A2&PERIOD)) SHR
00001300ALLOC F(FT17F001) DS(DECISION.DATA(A3&PERIOD)) SHR
00001400ALLOC F(FT18F001) DS(DECISION.DATA(A4&PERIOD)) SHR
00001500ALLOC F(FT19F001) DS(DECISION.DATA(A5&PERIOD))
                                                                               SHR
00001600ALLOC F(FT20F001) DS(DECISION.DATA(A6&PERIOD)) SHR
00001700ALLOC F(FT21F001) DS(DECISION.DATA(A7&PERIOD)) SHR
00001B00ALLOC F(FT11F001) DS(QUALITY.DATA(A&PERIOD)) OLD CATALOG +
00001810 UNIT(STORAGE) TRACKS SPACE(1,1) DIR(10) USING(TEMP)
00001900WRITE DATA SETS ARE ALLOCATED
00002000CALL 'U11502C.QUI.LOAD(INQUI)'
00002100EDIT COST.CNTL(A)
00002200C 700 /ZZ/&PERIOD./
00002300C 800 1500 /ZZ)/&PERIOD.)/ ALL
00002400C 1600 /ZZ./&PERIOD./
00002500C 2200 2300 /ZZ/&PERIOD./ ALL
00002600C 300 /????/&PASSWORD./
00002700SUBMIT
00002800C 700 /&PERIOD../ZZ./
00002900C 800 1500 /&PERIOD.)/ZZ)/ ALL
00003000C 1600 /&PERIOD../ZZ./
00003100C 2200 2300 /&PERIOD./AZZ/ ALL
00003200C 300 /&PASSWORD./???/
00003300END S
00003400FREEALL
```

APPENDIX D

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COMMAND PROCEDURES TO BE USED BY PARTICIPANTS FOR ENTERING DECISIONS

**** TSO FOREGROUND HARDCOPY **** DSNAME=U11502C.INPUTA.CLIST

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00000100CONTROL MSG 0000200FREEALL 00000400WRITE THIS PROGRAM WILL TAKE YOUR INPUT FOR THE WATER QUALITY 00000500WRITE SIMULATION GAME AND PREPARE THE DATA FILE 00000600WRITE 00000700WRITE ENTER YOUR TEAM NUMBER (E.G. 1) 00000900WRITE ENTER YOUR PERIOD NUMBER (E.G. 1) 00001000READ &FEAM 00001000READ &PERIOD 00001100SET &P=&PERIOD + 2 00001200ATTRIB TEMP BLKSIZE(6160) LRECL(80) RECFM(F B) 00001300ALLOC F(FT20F001) DS(PLANTA&P..CNTL) MOD USING(TEMP) 00001400ALLOC F(FT10F001) DS(PLANTA&PERIOD..CNTL) SHR 00001400ALLOC F(FT11F001) DS(DECISION.DATA(A&TEAM&PERIOD)) OLD 00001600WRITE DATA SETS ARE ALLOCATED 00001700CALL 'U11502C.SIMT.LOAD(TEMPNAME)' 00001800FREE F(FT11F001) ATTRLIST(TEMP) 00001900FREE F(FT20F001) ATTRLIST(TEMP)

APPENDIX E

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FORTRAN PROGRAM FOR COST CALCULATIONS

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	** TSO FOREGROUND HARDCOPY **** NAMS=Ull502C.MSIMU.CNTL	121
-		
	THIS IS THE MAIN PROGRAM WHICH CONTAINS COST FUNCTION TO CALCULATE00000100 THE COST OF EACH TEAM. THE PROGRAM WILL READ STUDENT DECISION 00000200 FILES, PLANT FILE, AND TDP FILE. THIS PROGRAM WILL GENERATE & 00000300 FINANCILA REPORT FOR EACH TEAM. 00000400 00000500	12:
•	CH -> CONVERSION FACTOR IMGD IS EQUAL TO 157.7 CUBIC METERS/HOUR 00000700 CHL -> CONVERSION FACTOR IMGD IS EQUAL TO 1381.525 MILLION LITERS/00008800 YEAR 00000900 YEAR 00000900 YEAR 000000000000000000000000000000000000	12:
	CTL -> CONVERSION FACTOR IMGD IS EQUAL TO 1381525 THOUSAND LITERS/00001000 YEAR 00001100 PLA(1) -> PRICE OF LABOR AND MATERIAL COSTS PER UNIT PRODUCT, FIRM00001200 I 00001300 POE(1) -> PRICE OF OTHER EXPENSES PER UNIT PRODUCT, FIRM I 00001400	c c
	POE(1) -> PRICE OF OTHER EXPENSES PER UNIT PRODUCT, FIRM I 00001400 PRI(1) -> PRICE PER UNIT PRODUCT, FIRM I 00001500 00001600 00001600 DIMENSION PR(7),PQ(7),PB0D(7),DQ(7),DB0D(7),FQ(7),FB0D(7),Q1(7), 00001800	124 125
	<pre>BOD1(7),02(7),BOD2(7),03(7),BOD3(7),04(7),BOD4(7),U0(7),U0(7),U00(7),00001900 *IT(7),IJ(7),IP(7),IS(7),BO(7),BBOD(7),ABOD(7),RAT(7),C1(7),U0(7),00002000 *VC(7),PC(7),WC(7),TC(7),SR(7),ALM(7),OE(7),TT1(7),TC1(7),TNE(7),00002100 *PRI(5),PLA(5),POE(5),PP(7,7),TDPN(7,7),PTDP(7,7),SBOD(7),CBOD(7),00002100</pre>	32 C
	*TPP(7) 00002300 CHARACTER*1 AR 00002500	с
	DATA CH,CML,CTL/157,7,1381,525,1381525,/ 00002600 DATA PRI/1200000.,1850000.,1800000.,1200000.,370000./ 00002700 DATA BQ,BBOD,C1,UC,TPP/7*0.,7*0.,7*0.,7*0.,7*0./ 00002800 00002900	33
. :	CALCULATE LABOR & MATERIAL COSTS AND OTHER EXPENSES 00003000 DC 27 1=1,5 00003100 PLL(1)=PRI(1)*0.6 00003200 POE(1)=PRI(1)*0.1 00003300 27 CONTINUE 00003400 READ DATA FROM STUDENT DECISION FILES 00003500	34
	D0 29 1+1,7 D0003600 READ(14+1,105) AR,IT(I),IJ(I),IS(I),IP(I),PR(I),PQ(I),PBOD(I),Q1(10003700 *),BOD(I),Q2(I),BOD2(I),Q3(I),BOD3(I),Q4(I),BOD4(I),UQ(I),UBOD(I),0003800 *FQ(I),FBOD(I),SBOD(I),CBOD(I) 00003900	3! C
-	SEED OF THE UNIFORMLY DISTRIBUTED PSEUDO-RADDOM NUMBERS 00004000 NRG-NRG+PR(I) 00004100 105 FORMAT(A1,41),F6.3,6(F6.3,F5.1)/F6.3,3F5.1) 00004200 29 CONTINUE 00004300 INITIALIZE PERMIT PRICE, PERMIT NUMBER, AND TOTAL PERMIT PRICE 00004400	u u u u
-	DO 240 1=1,7 00004500 DO 240 j=1,7 00004600 PP(I,j)=0. 00004700 TDPN(I,j)=0. 00004800	c c c
-	240 CONTINUE 00005000 READ PLANT DESIGN CAPACITY AND DESIGN BOD EFFLUENT CONCENTRATION 00005100 28 READ(11,106,END=30) I,DQ(I),DBOD(I) 00005200 106 FORMAT(12,118,F6.3,F5.1) 00005300 000 00005400	36
	READ TDP PRICE AND NUMBER OF PERMITS OF EACH TEAM 00005500 30 READ(22,107) ((PTDP(I,J),J=1,7),I=1,7) 00005600 107 FORMAT(7F10.0) 00005700 READ(24,108) ((TDPN(I,J),J=1,7),I=1,7) 00005800 06 FORMAT(7F10.2) 00005900	. 25

108 FORMAT(7F10.2)

.

			00001001
	C C	FIND FLOW RATES, BOD CONCENTRATIONS AND DESIGN BOD REMOVAL RATE FOR EACH INDIVIDUAL WASTEWATER TREATMENT PLANT OF INDUSTRIAL FIRMS	00006000
	C	DO 32 1=1,5	00006300
		GO TO (121,122,123,121,122,123,121,123),IS(I)	00006400
	121	BQ(1)=Q1(1)	00006500
E00000100		BBOD(I)=PBOD(I)	00006600
00000200		ABOD(I) = BOD1(I) RAT(I) = (BBOD(I) - DBOD(I))/BBOD(I)	00006700
00000300		GO TO 32	00006900
00000400	122	BQ(1) = Q2(1) .	00007000
00000500		BBOD(I)=PBOD(I)	00007100
00000600		ABOD(I)=BOD2(I)	00007200
/00000800		RAT(I)=(BEOD(I)-DEOD(I))/BEOD(I) GO TO 32	00007300
00000900	123	IF (IS(I).NE.6) GO TO 125	00007500
/00001000	c	DISCHARGE WITHOUT PERMIT -> USE UNIFORMLY DISTRIBUTED PSEUDO -	00007600
00001100	с	RANDOM NUMBER U TO CATCH INFRACTIONS IF U IS LESS THAN 60 PERCENT	00007700
M00001200		U=RANF(2*IABS(NRG)+1)	00007800
00001300 000C1400		IF (U.LE.0.6) GO TO 124	00007900
00001500	124	GO TO 125 PC(I)=200000.	00008000
00001600	125	BBOD(I)=PBOD(I)	00008200
00001700	120	ABOD(I)=0.	00008300
00001800		RAT(I)=0.	00008400
00001900	32	CONTINUE	00008500
00002000 00002100	~		00008600
00002200	с с	CALCULATE FLOW RATES, BOD CONCENTRATIONS AND DESIGN BOD REMOVAL RATES FOR MUNICIPAL WASTEWATER TREATMENT PLANTS	00008700
00002300	-	DO 33 I=1,3	00006900
00002400		BQ(6) = BQ(6) + Q2(1) + Q3(1)	00009000
00002500		BBOD(6) = BBOD(6) + Q2(I) * BOD2(I) + Q3(I) * BOD3(I)	00009100
00002600	33	CONTINUE	00009200
00002800		DO 34 $I=4,5$ BQ(7)=BQ(7)+Q2(I)+Q3(I)	00009300
00002900		BOD(7) = BOD(7) + Q2(1) + Q3(1) + Q3(1) + BOD3(1)	00009500
00003000	34	CONTINUE	00009600
00003100		DO 35 I=6.7	00009700
00003200		BQ(I)=BQ(I)+UQ(I)	00009800
00003300 00003400		BBOD(I) = (BBOD(I) + UQ(I) * UBOD(I)) / BQ(I)	00009900
00003500		ABOD(I)=CBOD(I) RAT(I)=(BBOD(I)-DBOD(I))/BBOD(I)	00010000
00003600	35	CONTINUE	00010200
100003700		· · · · ·	00010300
,00003500	с	CALCULATE INVESTMENT COSTS AND OPERATION COSTS	00010400
00003900 00004000		DO 36 I=1,7	00010500
00004100	с	Cl(I)=78239*DQ(I)**0.89*BBOD(I)**0.24*DBOD(I)**(-0.16)*0.25 IF (RAT(I).NE.0.) GO TO 128	00010600 00010900
00004200	č	DURING MAINTENANCE PERIOD, QUARTERLY INVESTMENT AND FIXED	00011000
00004300	с	OPERATION COSTS OF THE DISCHARGER IS EQUAL TO HALF OF THE NORMAL	00011100
00004400	ċ	COST	00011200
00004500 00004600	с	Cl(I)=0.5*Cl(I)	00011300
00004700	с	VC(1)=39244*BQ(1)**0.79*BBOD(1)**0.24*ABOD(1)**(-0.07)*0.25 CALCULATE TOTAL PERMIT PRICE, BUYING PERMIT IS PLUS, SELLING	00011400
00004800	č	PERMIT IS MINUS AND PRICE IS ALWAYS PLUS	00011500
00004900	•	DO 36 J=1.7	00011700
00005000		PP(I,J)=PTDP(I,J)*TDPN(I,J)	00011800
00005100	36	CONTINUE	00011900
00005200		C1(6)=78239*DQ(6)**0.89*200**0.24*DBOD(6)**(-0.16)*0.25 C1(7)=78239*DQ(7)**0.89*200**0.24*DBOD(7)**(-0.16)*0.25	00011910
00005400		DO 250 1=1,7	00011920 00012000
00005500		DO 250 J=1.7	00012100
00005600	250	TPP(I)=TPP(I)+PP(I,J)	00012200
00005700		C1(3)=C1(3)+(1671;*0.25)	00012300
00005800		Cl(4)=Cl(4)+(17552*0.25)	00012400
00005900		VC(3)=VC(3)+(6416*0.25)	00012500

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	VC(4)=VC(4)+(1445*0.25) 00012600
	CALCULATE WATER QUALITY-RELATED COSTS AND PROFIT 00012800
	DO 37 I=1.5 00012900
	UC(1) = (Q2(1) * CTL * 0.106 + Q3(1) * CTL * 0.106)/4 00013000
	IF BOD EFFLUENT CONCENTRATION EXCEEDS 250 MG/L THE FIRM HAS TO PAY00013100
	SURCHARGE FEE 00013200 IF (BOD2(I).LE.250) GO TO 51 00013300
	IF (BOD2(I).LE.250) GO TO 51 00013300 UC(I)=UC(I)+(Q2(I)*CML*0.443*(BOD2(I)-250))/4 00013400
51	IF (BOD3(1).LE.250) GO TO 52 00013500
	UC(1)=UC(1)+(Q3(1)+CML*0.443*(BOD3(1)-250))/4 00013600
52	WC(1)=C1(I)+VC(I)+UC(I)+PC(I)+TPP(I) 00013700 SR(I)=PR(I)*PRI(I) 00013800
	SR(I)=PR(I)*PRI(I) 00013800 ALM(I)=PR(I)*PLA(I) 00013900
	OE(1) - PR(1) + POE(1) 00014000
	TC(1)=WC(1)+ALM(1)+OE(1) 00014100
	TTI(I)=SR(I)-TC(I) 00014200 TAX IS 46 PERCENT 00014300
	TAX IS 46 PERCENT 00014300 TCI(I)=0.46*TTI(I) 00014400
	TNE(I)-(1-0.46)*TTI(I) 00014500
37	
	DO 36 1=1,3 00014700 UC(6)=UC(6)=UC(1) 00014800
38	CONTINUE 00014900
	DO 39 1=4,5 00015000
	UC(7)=UC(7)+UC(1) 00015100
39	CONTINUE 00015200 DO 40 I=6.7 00015300
	DO 40 I=6,7 00015300 WC(I)=C1(I)+VC(I)-UC(I)+TPP(I) 00015400
40	CONTINUE 00015500
	00015600
	PRINT OUTPUT FOR INDUSTRIAL FIRMS 00015700 DO 61 1=1.5 00015800
	CALL INFO(AR,I,IJ(1),IP(I),PR(I),DQ(I),DBOD(I),PQ(I),PBOD(I),UQ(I)00015900
	*,UBOD(I),SBOD(I),CBOD(I)) 00016000
	CALL SALT(IS(I),Q1(I),BOD1(I),Q2(I),BOD2(I),Q3(I),BOD3(I),Q4(I),BO00016100
	*D4(1)) 00016200 IF (RAT(1).EQ.0.) GO TO 153 00016300
	WRITE(6,158) RAT(1) 00016400
158	FORMAT(/1H0, DESIGN BOD REMOVAL RATE :', F7.2) 00016500
153	IF (FQ(I).LE.C.) GO TO 151 00016600
151	CALL SHUPGR(FQ(I),FBOD(I)) 00016700 WRITE(6.159) 00016800
159	FORMAT(/1H0,' WATER QUALITY-RELATED COSTS') 00016900
	WRITE(6,160) C1(1) 00017000
160	FORMAT(' QUARTERLY INVESTMENT AND FIXED OPERATING COSTS OF PLANT 00017100 *:',F9.0,' DOLLARS') 00017200
	*:',F9.0,' DOLLARS') 00017200 WRITE(6,161) VC(1) 00017300
161	
	*S') 00017500
162	WRITE(6,162) UC(1) 00017600 FORMAT(' INDUSTRIAL USER CHARGES :'.F9.0.' DOLLAR00017700
102	*S') 00017800
	IF (PC(I).EQ.0.) GO TO 155 00017900
	WRITE(6,163) PC(I) 00018000
163	FORMAT(' DISCHARGE WITHOUT PERMIT -> PENALTY COST :', F9.0, ' DOLL&R00018100 *5') 00018200
155	
	IF (TDPN(I,J)) 301,300,302 00016400
301	WRITE(6,310) ABS(TDPN(I,J)),I,J 00018500
310	FORMAT(' NUMBER OF PERMITS SOLD :',F9.2,' FROM TEAM ',12,' TO TE00018600 *AM ',12) 00018700
	WRITE(6,311) PTDP(I,J) 00018800
311	FORMAT(' UNIT PERMIT SELLING PRICE :', F9.0, ' DOLLAR00018900
	*5') 00019000
	WRITE(6,312) ABS(PP(1,J)) 00019100

•

312	PORMAT(' REVENUE FROM PERMITS *S')	:',F9.0,'	DOLLAR00019201 00019300
	IF (I.NE.7 .AND. J.NE.7) GO TO 300 IF (I.EQ.7 .AND. J.EQ.7) GO TO 221		00019400
302	WRITE(6,315) TDPN(I,J),J,I		00019500
315	FORMAT(' NUMBER OF PERMITS BOUGHT :', F9.2,' FROM	TEAM '.12.	
	*AM ',I2)		00019800
	WRITÉ(6,316) PTDP(I,J) Format(' unit permit buying price		00019900
316	FORMAT(' UNIT PERMIT BUYING PRICE	:',F9.0,'	DOLLAR00020000
	*S')		00020100
317	WRITE(6,317) PP(I,J) Format(' Cost of Permits		00020200 DOLLAR00020300
317	*S')	: ,:9.0,	00020400
300	CONTINUE		00020500
221	WRITE(6,169) WC(1)		00020600
169	FORMAT(' TOTAL CURRENT COSTS	:',F9.0,'	DOLLAR00020700
	*5')		00020800
	WRITE(6,170)		00020900
170	FORMAT(/1H0, ' PROFIT & LOSS STATEMENT')		00021000
171	WRITE(6,171) SR(I) Format(' Total Sales Revenue		00021100 DOLLAR00021200
1/1	*S')	: , 19.0,	00021300
	WRITE(6,172) ALM(1)		00021400
172	FORMAT(' LABOR AND MATERIAL COSTS	:',F9.0,'	DOLLAR00021500
	*5')		00021600
	WRITE(6,173) OE(I)		00021700
173	FORMAT(' OTHER EXPENSES *S')	:',F9.0,'	DOLLAR00021800
	WRITE(6,174) TC(1)		00021900 00022000
174	FORMAT(' TOTAL EXPENSES	:'.F9.0.'	DOLLAR00022100
	*S')		00022200
	WRITE(6,175) TTI(1)		00022300
175	FORMAT(' TOTAL TAXABLE INCOME	:',F9.0,'	DOLLAR00022400
	*5') WRITE(6,176) TCI(1)		00022500
176	FORMAT(' TAX ON CURRENT INCOME	. 59 0.	00022600 DOLLAR00022700
	*5')		00022800
	WRITE(6,177) TNE(1)		00022900
177	FORMAT(' NET EARNING	:',F9.0,'	DOLLAR00023000
	*S')		00023100
	<pre>WRITE(23,230) AR,I,IJ(I),IS(I),IP(I),PR(I),PQ(I), *1(I),Q2(I),BOD2(I),Q3(I),BOD3(I),Q4(I),BOD4(I),UQ</pre>		
	*,FBOD(I),SBOD(I),CBOD(I),RAT(I),Cl(I),VC(I),UC(I)) PC(I) WC(I	1).59(100023300
	*), ALM(I), OE(I), TC(I), TTI(I), TCI(I), TNE(I), TPP(I)	,,	00023500
230	FORMAT(A1,411,F6.3,6(F6.3,F5.1)/F6.3,3F5.1,F5.3,6	6F9.0/6F9.0	
61	CONTINUE		00023700
~			00023800
с	PRINT OUTPUT FOR MUNICIPAL TREATMENT PLANTS DO 62 I=6,7		00023900
	CALL INFO(AR, I, IJ(I), IP(I), PR(I), DQ(I), DBOD(I), PC	(I). PROD(I)	00024000
	*, UBOD(I), SBOD(I), CBOD(I))		00024200
	IF (I.EQ.6) GO TO 140		00024300
	IF (I.EQ.7) GO TO 141		00024400
140	DO 142 $J=1,3$		00024500
	IF (Q2(J).LE.O.) GO TO 143 WRITE(6,180) J.Q2(J)		00024600
180	FORMAT(' ACTUAL PRETREATED WASTEWATER FLOW RATE F	ROM INDUST	
	*RM'.I2.' :'.F7.3.' MGD')		00024900
	WRITE(6,181) J,BOD2(J)		00025000
181		T CONCENTRA	
147	*ROM INDUSTRIAL FIRM', 12, ':', F5.1, ' MG/L')		00025200
143	IF (Q3(J).LE.O.) GO TO 142 WRITE(6.162) J.Q3(J)		00025300
182	FORMAT(' ACTUAL RAW WASTEWATER FLOW RATE FROM INI	DUSTRIAL FI	RM'.12.00025500
	*' :',F7.3,' MGD')		00025600
	WRITE(6,183) J,BOD3(J)		00025700

183		
-03	3 FORMAT(' ACTUAL RAW WASTEWATER BOD INFLUENT CONCENTRATION FROM INDO	0025800
		0025900
142	2 CONTINUE 00	0026000
	GO TO 154 01	0026100
141		0026200
747		
		0026300
	WRITÉ(6,184) J,Q2(J) 0	0026400
184		0026500
104		
		0026600
	WRITE(6,185) J,BOD2(J) 0	0026700
185		0026800
100		
		0026900
145	5 IF (Q3(J).LE.0.) GO TO 144 0	0027000
	WRITE(6,186) J,Q3(J) 0	0027100
186	5 FORMATT ACTUAL RAW WASTEWATER FLOW RATE FROM INDUSTRIAL FIRM ,12,0	
		0027300
	WRITE(6,187) J,BOD3(J) 0	0027400
187		
-0/	FORMALL ACTUAL RAW WASTEWATER BOD INFLUENT CONCENTRATION FROM INDU	
	*USTRIAL FIRM',I2,' :',F5.1,' MG/L') 0	0027600
144 154 188	4 CONTINUE 0	0027700
		0027800
	4 WRITE(6,188) BQ(1) 0	
188	8 FORMAT(' ACTUAL TOTAL WASTEWATER FLOW RATE 0	0027900
	* - · F7 3 ' MGD') 0	0028000
	uptrp(6, 199) ppon(1)	0028100
189	9 FORMAT(' ACTUAL AVERAGE BOD INFLUENT CONCENTRATION 0	0028200
	* :',F5.1,' MG/L') 0	0028300
		0028400
191		
	*!ON :',F5.1,' MG/L') 0	0028600
	WRITE(6,190) RAT(1) 0	0028700
100		0028800
190	U FORMAT(/THU, DESIGN BOD REMOVAL RATE :,F/.2) U	
	IF (FQ(I).LE.0.) GO TO 152 0	0028900
	CALL SHUPGR(FQ(I), FBOD(I)) 0	0029000
152		0029100
201		
		0029200
	WRITE(6.202) C1(I) 0	0029200
	WRITE(6,202) C1(I) 0	0029300
202	0 WRITE(6,202) C1(I) 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0	0029300 0029400
	<pre>WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0,' DOLLARS') 0</pre>	0029300 0029400 0029500
	<pre>WRITE(6,202) C1(I) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0,' DOLLARS') 0</pre>	0029300 0029400
202	WRITE(6,202) C1(I) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9.0,' DOLLARS') 0 WRITE(6,203) VC(I) 0	0029300 0029400 0029500 0029500
202	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0,' DOLLARS') 0 wRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',F0	0029300 0029400 0029500 0029600 0029600 0029700
202	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS ', F0 *9.0,' DOLLARS') 0	0029300 0029400 0029500 0029600 0029600 0029700 0029800
202	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS ', F0 *9.0,' DOLLARS') 0	0029300 0029400 0029500 0029600 0029600 0029700
202	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,* DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9,0,* DOLLARS') *9,0,* DOLLARS') IF (1,EQ.6) GO TO 146	0029300 0029400 0029500 0029600 0029700 0029700 0029800 0029900
202 203	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9.0, DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9.0,' DOLLARS') 0 IFORMAT(' OPERATION COSTS :',FO *9.0,' DOLLARS') 0 IF (1.EQ.6) GO TO 146 0 IF (1.EQ.7) GO TO 147 0	0029300 0029400 0029500 0029600 0029700 0029800 0029800 0029900 0029900
202	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,* DOLLARS') WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9.0,* DOLLARS') *1,0,* DOLLARS') *1,0,* DOLLARS') *1,0,* DOLLARS') *1,0,* DOT 0146 1,6 0 1,7 (1,20,4) 0 0,7 DO 146 0 1,7 1,20,4) 0 0,0 140 0 1,10 0 0	0029300 0029400 0029500 0029600 0029700 0029800 0029900 0029900 0030000 0030100
202 203	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9.0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9.0,' DOLLARS') 0 IF (I.EQ.6) GO TO 146 0 IF (I.EQ.7) GO TO 147 0 6 DO 148 J=1,3 0 1F (U.J.LE.0.) GO TO 148 0	0029300 0029400 0029500 0029600 0029700 0029800 0029900 0030000 0030100 0030200
202 203	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9.0.* DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9.0.* DOLLARS') "9.0.* DOLLARS') 0 TORMATICA COSTS *9.0.* DOLLARS') 1F (1.EQ.6) GO TO 146 1F (1.EQ.7) GO TO 147 0 DO 146 J=1.3 1F (UC(3),LE.0.) GO TO 148 0 DO 146 COMPUTED COMPUTED	0029300 0029400 0029500 0029600 0029700 0029800 0029900 0029900 0030000 0030100
202 203 146	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9.0.* DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9.0.* DOLLARS') "9.0.* DOLLARS') 0 TORMATICA COSTS *9.0.* DOLLARS') 1F (1.EQ.6) GO TO 146 1F (1.EQ.7) GO TO 147 0 DO 146 J=1.3 1F (UC(3),LE.0.) GO TO 148 0 DO 146 COMPUTED COMPUTED	0029300 0029400 0029500 0029600 0029700 0029800 0029900 0030000 0030100 0030100 0030200 0030300
202 203	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9.0.* DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9.0.* DOLLARS') "9.0.* DOLLARS') 0 TORMATICA COSTS *9.0.* DOLLARS') 1F (1.EQ.6) GO TO 146 1F (1.EQ.7) GO TO 147 0 DO 146 J=1.3 1F (UC(3),LE.0.) GO TO 148 0 DO 146 COMPUTED COMPUTED	0029300 0029400 0029500 0029700 0029800 0029800 0029900 0030000 0030100 0030200 0030200 0030200
202 203 146 204	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 IF (1.EQ.6) GO TO 146 0 IF (1.EQ.6) GO TO 147 0 D D 148 J=1,3 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *:', F9.0, ', DOLLARS') 0	0029300 0029400 0029500 0029700 0029700 0029900 0030100 0030100 0030300 0030300 0030300 0030300
202 203 146	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 IF (1.EQ.6) GD TO 146 0 IF (1.EQ.6) GD TO 146 0 D D14 B J=1,3 0 IF (UC(J),LE.0.) GO TO 148 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *:',F?0.,', DOLLARS') 0	0029300 0029400 0029500 0029700 0029800 0029800 0029900 0030000 0030100 0030200 0030200 0030200
202 203 146 204	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9,0,* DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',F0 *9,0,* DOLLARS') 0 IF (1.EQ.6) GO TO 146 0 IF (1.EQ.7) GO TO 146 0 IF (1.EQ.7) GO TO 147 0 0 DD 148 J=1,3 0 IF (0.C(3), LE.0.) GO TO 148 0 WRITE(6,204) J,UC(J) 0 VF FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: (F9.0, 'DOLLARS') 0 CONTINUE 0	0029300 0029400 0029500 0029600 0029800 0029800 0030000 0030100 0030200 0030200 0030400 0030500 0030600
202 203 146 204 148	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 IF (1.EQ.6) GD TO 146 0 IF (1.EQ.7) GD TO 147 0 D D148 S]=1,3 0 WRITE(6,204) J.UC(1) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 8 CONTINUE 0 0 GG TO 150 0 0	0029300 0029500 0029500 0029700 0029800 0029900 0029900 0030100 0030100 0030200 0030400 0030500 0030500 0030600
202 203 146 204	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,* DOLLARS') WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,* DOLLARS') IF (1.EQ.6) GO TO 146 0 IF (1.EQ.7) GO TO 146 0 IF (1.EQ.7) GO TO 146 0 IF (1.EQ.20) JOC TO 146 0 VRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 *1, F9.0,* DOLLARS') 0 G CONTINUE 0 0 G TO 150 0 0 YD D149 J=4,5 0 0	0029300 0029500 0029500 0029600 0029800 0029900 0030100 0030100 0030200 0030400 0030500 0030500 0030600 0030600
202 203 146 204 148	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 146 0 1F (1.EQ.7) GO TO 147 0 6 DO 148 J=1,3 0 1F (UC(J),LE.0.) GO TO 148 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MONICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 5':, (P3.0,') DOLLARS') 0 8 CONTINUE 0 7 DO 149 J=4,5 0 17 DOL48, (J.LE.0.) GO TO 149 0	0029300 0029400 0029500 0029600 0029800 0029800 0030100 0030200 0030300 0030400 0030400 0030500 0030600 0030600 0030800
202 203 146 204 148	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0.* DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS 1',F0 *9.0.* DOLLARS') 0 *9.0.* DOLLARS') 0 *9.0.* DOLLARS') 1',F0 *9.0.* DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 147 0 0 DD 148 J=1,3 0 1F (1.EQ.7) GO TO 146 0 WRITE(6,204) J.UC(J) 0 CONTINUE 0 GO TO 150 0 7 0 1D 149 J=4,5 0 1F (UC(J).LE.0.) GO TO 149 0 1VDUME(2004) J.UC(J) 0 0 0 0 0 0 0 0 0	0029300 0029500 0029500 0029600 0029800 0029900 0030100 0030100 0030200 0030400 0030500 0030500 0030600 0030600
202 203 146 204 148 147	WRITE(6,202) C1(1) 0 2 FORMATI' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9.0.* DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS 1',F0 *9.0.* DOLLARS') 0 *9.0.* DOLLARS') 0 *9.0.* DOLLARS') 1',F0 *9.0.* DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 147 0 0 DD 148 J=1,3 0 1F (1.EQ.7) GO TO 146 0 WRITE(6,204) J.UC(J) 0 CONTINUE 0 GO TO 150 0 7 0 1D 149 J=4,5 0 1F (UC(J).LE.0.) GO TO 149 0 1VDUME(2004) J.UC(J) 0 0 0 0 0 0 0 0 0	0029300 0029500 0029500 0029700 0029800 0029800 0030100 0030200 0030200 0030400 0030500 0030400 0030600 0030800 0030800 0030900 0031000
202 203 146 204 148	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 146 0 1F (1.EQ.7), GO TO 146 0 1F (UC(J),LE.0.) GO TO 148 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 6 CONTINUE 0 7 DO 149 J=4,5 0 8 CONTINUE 0 9 D 149 J=4,5 0 9 D 149 J=4,5 0 9 D 149 J=4,5 0 9 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0	0029300 0029400 0029500 0029500 0029000 0029000 0030000 0030200 0030200 0030200 0030500 0030500 0030500 0030600 0030600 0030900 0031000
202 203 146 204 148 147 205	WRITE(6,202) C1(1) 0 PORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9,0,* DOLLARS') WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',F0 *9,0,* DOLLARS') 0 1F (1.20,6) GO TO 146 0 0 1F (1.20,6) GO TO 146 0 0 1F (1.20,6) GO TO 146 0 0 1F (1.62,04) J.0C(3) 0 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 6 CONTINUE 0 0 G GO TO 150 0 0 7 DO 149 J*4,5 0 0 9 DO 149 J*4,5 0 0 9 DO 149 J*4,5 0 0 9 CONTINUE 0 0 9 CONTINUE 0 0 9 DO 149 J*4,5 0 0 9 IF (UC(J).LE.0.) GO TO 149 0 0 9 VRITE(6,205) J.UC(J) 0 0 9 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 9 *': P.9.0, 'DOLLARS') 0 0	0029300 0029500 0029500 0029500 0029700 0029000 0030000 0030100 0030100 0030400 0030400 0030400 0030400 0030400 0030400 0030400 0030200 0031100
202 203 146 204 148 147 205	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 IF (1.EQ.6) GO TO 146 0 IF (1.EQ.7) GO TO 147 0 D D 148 J=1,3 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 6 CONTINUE 0 6 CONTINUE 0 7 DO 149 J=4,5 0 17 (1.J.LE.0.) GO TO 149 0 WRITE(6,205) J.UC(J) 0 8 CONTINUE 0 9 D 149 J=4,5 0 10 T 00 150 0 7 DD 149 J=4,5 0 17 (UC(J),LE.0.) GO TO 149 0 WRITE(6,205) J.UC(J) 0 8 CONTINUE 0 9 CONTINUE 0	0029300 0029400 0029500 0029500 0029700 0029000 0029000 0030200 0030200 0030200 0030500 0030500 0030500 0030600 0030600 0030900 0031000
202 203 146 204 148 147 205	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,* DOLLARS') WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,* DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 147 0 0 D0 148 J=1,3 0 1F (1.EQ.7) GO TO 146 0 HRITE(6,204) J.UC(3) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 c CONTINUE 0 G CO TO 150 0 7 IF (UC(1),LE.0.) GO TO 149 0 WRITE(6,206) J.UC(3) 0 5 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 0 D148 J=4,5 0 1F (UC(1),LE.0.) GO TO 149 0 WRITE(6,205) J.UC(3) 0 5 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: ,F9.0, 'DOLLARS') 0 5 CONTINUE 0 6 CONTINUE 0 7 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: ,F9.0, 'DOLLARS') 0	
202 203 146 204 148 147 205 49 250	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,* DOLLARS') WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,* DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 147 0 0 D0 148 J=1,3 0 1F (1.EQ.7) GO TO 146 0 HRITE(6,204) J.UC(3) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 c CONTINUE 0 G CO TO 150 0 7 IF (UC(1),LE.0.) GO TO 149 0 WRITE(6,206) J.UC(3) 0 5 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 0 D148 J=4,5 0 1F (UC(1),LE.0.) GO TO 149 0 WRITE(6,205) J.UC(3) 0 5 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: ,F9.0, 'DOLLARS') 0 5 CONTINUE 0 6 CONTINUE 0 7 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: ,F9.0, 'DOLLARS') 0	
202 203 146 204 148 147 205	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9,0,'DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9,0,'DOLLARS') IF (1.EQ.6) GO TO 146 1F (1.EQ.7) GO TO 147 6 DO 148 J=1,3 1F (1.EQ.7) GO TO 146 WRITE(6,204) JUC(3) 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 6 CONTINUE G CO TO 150 7 IF (UC(J),LE.0.) GO TO 149 WRITE(6,205) JUC(3) 6 CONTINUE 10 149 J=4,5 17 IF (UC(J),LE.0.) GO TO 149 18 CONTINUE 19 OT 149 J=4,5 19 OT 149 J=4,5 19 OT 149 J=4,5 19 CONTINUE 10 FORMAT(' TOTAL MUNICIPAL USER CHARGES	0029300 0029400 0029500 0029500 0029700 0029700 003000 003100 003020 003020 003020 003020 003020 003020 003020 003020 0031000 0031200 0031200
202 203 146 204 148 147 205 49 250	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9,0,'DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9,0,'DOLLARS') IF (1.EQ.6) GO TO 146 1F (1.EQ.7) GO TO 147 6 DO 148 J=1,3 1F (1.EQ.7) GO TO 146 WRITE(6,204) JUC(3) 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 C and J=4,5 0 C T 150 7 IF (UC(1),LE.0.) GO TO 149 1 G CONTINUE 1 G CONTINUE 1 G CONTINUE 1 F (UC(1),LE.0.) GO TO 149 1 C CONTINUE 1 C CONTINUE 1 F (UC(1),LE.0.) GO TO 149 0 F ORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 CONTINUE 0 CONTINUE 0 WRITE(6,206) UC(1) 0 WRITE(6,206) UC(1) 0 WRITE(6,206) UC(1) 0 F ORMAT(' TOTAL MUNICIPAL USER CHARGES	
202 203 146 204 148 147 205 49 250	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 IF (1.2Q.6) GO TO 146 0 IF (1.2Q.7) GO TO 147 0 D D 148 J=1,3 0 WRITE(6,204) J.UC(3) 0 HRITE(6,204) J.UC(3) 0 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM', 12,' 0 6 CONTINUE 0 6 CONTINUE 0 7 DD 149 J=4,5 0 17 F(10(1), LE.0.) GO TO 149 0 WRITE(6,205) J.UC(3) 0 7 DD 149 J=4,5 0 9 CONTINUE 0 9 CONTINUE 0 9 CONTINUE 0 9 CONTINUE 0 0 WRITE(6,205) J.UC(1) 0 9 CONTINUE 0 0 WRITE(6,206) UC(1) 0 0 WRITE(6,206) UC(1) 0 0 WRITE(6,206) UC(1) 0 0 WRITE(6,206) UC(1) 0 0 FORMAT	0029300 0029400 0029500 0029500 0029700 0029700 0030000 0030100 0030200 0030200 0030200 0030200 0030200 0030200 0030200 0030200 0031000 0031200 0031400
202 203 146 204 148 147 205 49 250	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,'DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS *9,0,'DOLLARS') IF (1.EQ.6) GO TO 146 1F (1.EQ.7) GO TO 147 6 DO 148 J=1,3 0 FORMAT(' MURICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 WRITE(6,204) J.UC(3) 4 FORMAT(' MURICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 Continue GG TO 150 7 IF (UC(1),LE.0.) GO TO 149 WRITE(6,205) J.UC(3) 6 CONTINUE 0 DO 149 J=4,5 1F (UC(1),LE.0.) GO TO 149 WRITE(6,205) J.UC(3) 5 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 WRITE(6,205) J.UC(3) 5 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 WRITE(6,205) J.UC(3) 6 FORMAT(' TOTAL MUNICIPAL USER CHARGES 0 WRITE(6,206) UC(1) 0 FORMAT(' TOTAL MUNICIPAL USER CHARGES *1, P9.0, 'DOLLARS') 0 FORMAT(' TOTAL MUNICIPAL USER CHARGES *5, P0.0, 'DOLLARS')	0029300 0029400 0029500 0029500 0029700 0029700 003000 003100 003020 0030200 0030200 0030200 0030200 0030200 0030200 0031000 0031200 0031600
202 203 146 204 148 147 205 249 206	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO "9.0," DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS "9.0," DOLLARS') IF (1.EQ.7) GO TO 146 1F (1.EQ.7) GO TO 147 0 D0 148 J=1,3 WRITE(6,204) J.UC(3) 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' *: ',F0,0,' DOLLARS') 8 CONTINUE 0 D0 149 J=4,5 0 TF (UC(1).LE.0.) GO TO 149 WRITE(6,205) J.UC(3) *: ',F0,0,' DOLLARS') 8 CONTINUE 0 D0 149 J=4,5 0 TF (UC(1).LE.0.) GO TO 149 WRITE(6,205) J.UC(3) 9 CONTINUE 0 CO TO 150 9 CONTINUE 0 WRITE(6,205) J.UC(3) *: ',F9.0,' DOLLARS') 9 CONTINUE 0 WRITE(6,206) U.C(1) 0 VRITE(6,206) U.C(1) 0 VRITE(6,206) J.J.LRS') 0 0 U.ARS') 0 0 U.ARS') <t< td=""><td>0029300 0029400 0029500 0029600 0029700 0029700 003020 0030100 0030200 0030200 0030200 0030200 0030200 0030200 0030200 0030200 0031000 0031200 0031400 0031600</td></t<>	0029300 0029400 0029500 0029600 0029700 0029700 003020 0030100 0030200 0030200 0030200 0030200 0030200 0030200 0030200 0030200 0031000 0031200 0031400 0031600
202 203 146 204 148 147 205 49 250	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,'DOLLARS') 0 3 FORMAT(' OPERATION COSTS :',FO *90,'DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.6) GO TO 147 0 0 D0 148 J=1,3 0 1F (1.EQ.7) GO TO 146 0 1F (1.EQ.7) GO TO 146 0 VRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 *1: /F9.0,' DOLLARS') 0 G CONTINUE 0 GO TO 150 0 7 IF (UC(J).LE.0.) GO TO 149 0 WRITE(6,205) J.UC(J) 0 VRITE(6,205) J.UC(J) 0 9 CONTINUE 0 9 CONTINUE 0 0 WRITE(6,205) J.UC(J) 0 9 CONTINUE 0 0 WRITE(6,206) UC(I) 0 0 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 0 WRITE(6,206) UC(I) 0 0 FORMAT(' TOTAL MUNICIPAL USER CHARGES ',FO *1, P5.0, 'DOLLARS') 0 <td< td=""><td></td></td<>	
202 203 146 204 148 147 205 149 205 206	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO *9,0,'DOLLARS') 0 3 FORMAT(' OPERATION COSTS :',FO *90,'DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.6) GO TO 147 0 0 D0 148 J=1,3 0 1F (1.EQ.7) GO TO 146 0 1F (1.EQ.7) GO TO 146 0 VRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',I2,' 0 *1: /F9.0,' DOLLARS') 0 G CONTINUE 0 GO TO 150 0 7 IF (UC(J).LE.0.) GO TO 149 0 WRITE(6,205) J.UC(J) 0 VRITE(6,205) J.UC(J) 0 9 CONTINUE 0 9 CONTINUE 0 0 WRITE(6,205) J.UC(J) 0 9 CONTINUE 0 0 WRITE(6,206) UC(I) 0 0 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 0 WRITE(6,206) UC(I) 0 0 FORMAT(' TOTAL MUNICIPAL USER CHARGES ',FO *1, P5.0, 'DOLLARS') 0 <td< td=""><td></td></td<>	
202 203 146 204 148 147 205 249 206	WRITE(6,202) C1(1) 0 2 FORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO "9,0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO *9,0,' DOLLARS') 0 IF (1.EQ.6) GO TO 146 0 IF (1.EQ.7) GO TO 147 0 D D 148 J=1,3 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *:',F9.0,' DOLLARS') 0 8 CONTINUE 0 GO TO 150 0 7 DD 149 J=4,5 0 17 (YP10,'L0LARS') 0 8 CONTINUE 0 9 CONTINUE 0 0 WRITE(6,206) UC(1) 0 0 WRITE(6,206) UC(1) 0 0 FORMAT(' MUNICIPAL USER CHARGES 1',FO 9 CONTINUE 0 0 CONTINUE 0 0 CONTINUE 0 0 CONTINUE 0	$\begin{array}{c} 0 & 2 & 3 & 0 \\ 0 & 2 & 3 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0$
202 203 146 204 148 147 205 149 205 206	WRITE(6,202) C1(1) 0 PORMAT(' ANNUAL INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 *9,0,' DOLLARS') WRITE(6,203) VC(1) 3 FORMAT(' OPERATION COSTS :',F0 *9,0,' DOLLARS') IF (1.20,6) GO TO 146 1F (1.20,6) GO TO 147 0 D 148 J=1,3 0 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 KRITE(6,204) J,DC(3) 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 6 CONTINUE G GO TO 150 7 DO 149 J=4,5 1F (UC(1),LE,0.) GO TO 149 WRITE(6,205) J,UC(3) 7 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 CONTINUE 0 GO TO 150 7 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 WRITE(6,205) J,UC(3) 7 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 TORTAUE 0 ORITE(5,206) UC(1) 0 FORMAT(' TOTAL MUNICIPAL USER CHARGES *1,*P0,*0,*1,*10,*10,*10,*10,*10,*10,*10,*10,	0029300 0029400 0029500 0029600 0029700 0029700 003000 0031000 0030200 0030200 0030400 0030500 0030500 0030500 0031400 0031400 0031500 0031700 0031700
202 203 146 204 148 147 205 149 205 206	WRITE(6,202) C1(1) 0 PORMAT(' ANUGLI INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 "9.0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',F0 "9.0,' DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 147 0 0 D0 148 J=1,3 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: (.F0.0,' DOLLARS') 0 8 CONTINUE 0 GG TO 150 0 7 DO 149 J=4,5 0 9 CONTINUE 0 0 HITE(6,206) UC(1) 0 6 FORMAT(' TOTAL MUNICIPAL USER CHARGES :',F0 *1, P3.0, ' DOLLARS') 0 9 CONTINE 0 0 HITE(6,206) UC(1) 0 6 FORMAT(' TOTAL MUNICIPAL USER	0029300 0029400 0029500 0029600 0029700 0029600 0030000 0030100 0030200 0030400 0030400 0030400 0030400 0030400 0030400 0030400 0031000 0031000 0031000 0031000 0031400 0031800 0031800 0031800 0031800
202 203 146 204 148 147 205 205 206 206	WRITE(6,202) C1(1) 0 PORMAT(' ANUGLI INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',F0 "9.0,' DOLLARS') 0 WRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',F0 "9.0,' DOLLARS') 0 17 (1.EQ.6) GO TO 146 0 18 (1.EQ.7) GO TO 147 0 19 (1.EQ.7) GO TO 147 0 19 (1.EQ.7) GO TO 148 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 *: (.F0.0,' DOLLARS') 0 8 CONTINUE 0 17 (10.1), LE.0.) GO TO 149 0 WRITE(6,204) J.UC(3) 0 9 CONTINUE 0 0 WRITE(6,206) UC(1) 0 6 FORMAT(' TOTL MUNICIPAL USER CHARGES :',F0 9 CONTINUE 0 0 WRITE(6,206) UC(1) 0 10 FORMAT(' TOTL MUNICIPAL USER CHARGES :',F0 9 CONTINE 0<	0029300 0029400 0029500 0029600 0029700 0029600 0030000 0030100 0030200 0030400 0030400 0030400 0030400 0030400 0030400 0030400 0031000 0031000 0031000 0031000 0031400 0031800 0031800 0031800 0031800
202 203 146 204 148 147 205 149 205 206	WRITE(6,202) C1(1) 0 PORMAT(' ANUGLI INVESTMENT AND FIXED OPERATING COSTS OF PLANT :',FO "9.0,' DOLLARS') 0 MRITE(6,203) VC(1) 0 3 FORMAT(' OPERATION COSTS :',FO "9.0,' DOLLARS') 0 1F (1.EQ.6) GO TO 146 0 1F (1.EQ.7) GO TO 146 0 1F (1.EQ.7) GO TO 146 0 1F (UC(J).LE.0.) GO TO 148 0 WRITE(6,204) J.UC(J) 0 4 FORMAT(' MUNICIPAL USER CHARGE FROM INDUSTRIAL FIRM',12,' 0 6 CONTINCE 0 6 GO TO 150 0 7 DO 149 J=4,5 0 1F (UC(J).LE.0.) GO TO 149 0 WRITE(6,205) J.UC(J) 0 8 CONTINCE 0 9 CONTINCE 0 9 CONTINCE 0 9 CONTINCE 0 0 WRITE(6,206) UC(1) 0 6 FORMAT(' TODAL MUNICIPAL USER CHARGES :',FO 9 (0, ' DOLLARS') 0 0 WRITE(6,206) UC(1) 0 1 FORMAT(' TOTAL MUNICIPAL USER CHARGES :',FO 9 (0, ' DOLLARS') 0 0 <	0029300 0029400 0029500 0029600 0029700 0029600 0030000 0030100 0030200 0030400 0030400 0030400 0030400 0030400 0030400 0030400 0031000 0031000 0031000 0031000 0031400 0031800 0031800 0031800 0031800

	*S')	00032:00
	WRITE(6,412) ABS(PP(I,J))	00032500
412	FORMAT(' REVENUE FROM PERMITS :', F9.0, ' DOLLA	R00032600
	*S')	00032700
	IF (I.NE.7 .AND, J.NE.7) GO TO 400	00032800
	IF (I.EQ.6 .AND, J.EQ.7) GO TO 400	00032900
	IF (I.EQ.7 .AND. J.EQ.7) GO TO 222	00033000
402	WRITE(6,415) TDPN(I,J),J,I	00033100
415	FORMAT(' NUMBER OF PERMITS BOUGHT :', F9.2,' FROM TEAM ', 12,' TO T	
	*AM ',12)	00033300
	$MP(T_{1}^{(2)}) = MP(T_{1}^{(2)})$	00033400
416	WRITE(6,416) PTDP(I,J) FORMAT(' UNIT PERMIT BUYING PRICE :',F9.0,' DOLLA	
410	*S')	00033600
		00033700
417	WRITE(6,417) PP(I,J) FORMAT(' COST OF PERMITS :',F9.0,' DOLLA	
41/	*S')	
400	CONTINUE	00033900
222		00034000
210	WRITE(6,210) WC(I)	00034100
210		00034200
	*9.0, ' DOLLARS')	00034300
	WRITE(23,230) AR, I, IJ(I), IS(I), IP(I), PR(I), BQ(I), BBOD(I), Q1(I), BO	
	*1(I),Q2(I),BOD2(I),Q3(I),BOD3(I),Q4(I),BOD4(I),UQ(I),UBOD(I),FQ(I	100034500
	*, FBOD(1), SBOD(1), CBOD(1), RAT(1), Cl(1), VC(1), UC(1), PC(1), WC(1), SR(
	*),ALM(I),OE(I),TC(I),TTI(I),TCI(I),TNE(I),TPP(I)	00034700
62	CONTINUE	00034800
	STOP	00034900
	END	00035000
_		00035100
с	THIS SUBROUTINE IS USED FOR PRINTING BASIC INFORMATION	00035200
	SUBROUTINE INFO(AR, IA, IJ, IP, PRIT, DQIT, DEODIT, PQIT, PBODIT, UQ1IT,	00035300
	*UBODIT, SBODIT, CBODIT)	00035400
	CHARACTER*1 AR	00035500
	WRITE(6,112)	00035600
112	FORMAT(1H1,/1H0,' WATER QUALITY SIMULATION GAME')	00035700
	WRITE(6,114) AR	00035600
114	FORMAT(1H0,' REGION :',1X,A1)	00035900
	WRITE(6,105) IP	00036000
105	FORMAT(' GAME PERIOD :',12)	00036100
	WRITE(6,115) IA	00036200
115	FORMAT(' REPORT FOR TEAM :',12)	00036300
	WRITE(6,125)	00036400
125	FORMAT(/1H0,' DECISIONS FOR WATER QUALITY MANAGEMENT')	00036500
	WRITE(6,135) DQIT	00036600
135	FORMAT(' CURRENT DESIGN CAPACITY :',F7.3,' MGD')	00036700
	WRITE(6,145) DBODIT FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION:',F5.1,' MG/	00036800
145	FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION:', F5.1,' MG/	L00036900
	**)	00037000
	WRITE(6,146) SBODIT	00037100
146	FORMAT(' CURRENT MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION	00037200
	*TO THE RIVER:', F6.1,' MG/L')	00037300
	IF (IJ.GT.1) GO TO 101	00037400
	WRITE(6,155)	00037500
155	FORMAT(' THIS IS INDUSTRIAL FIRM')	00037600
	GO TO 102	00037700
101	WRITE(6,165)	00037800
165	FORMAT(' THIS IS MUNICIPAL TREATMENT PLANT')	00037900
	WRITE(6,175) UQIIT	00038600
175	FORMAT(ACTUAL RESIDENTIAL WASTEWATER FLOW RATE	00038100
	* :',F7.3,' MGD')	00038200
	WRITE(6,185) UBODIT	00038300
185	FORMAT(' ACTUAL RESIDENTIAL WASTEWATER BOD INFLUENT CONCENTRATION	
	* :',F5.1,' MG/L')	00038500
	GO TO 103	00036600
102	IF (IA.EQ.2) GO TO 104	00038700
	WRITE(6,195) PRIT	00038800
195	FORMAT(' PRODUCTION FORCAST :', F7.3,' MILLI	

	*N POUNDS OF PRODUCT')			00039000
	GO TO 106			00039100
104 196	WRITE(6,196) PRIT Format(' production forcast	:'.F7.3.'		00039200
190	*NS OF BIRDS')	· , F / . 3 ,		00039400
106				00030500
205	FORMAT(' EXPECTED WASTEWATER FLOW RATE	:'.F7.3.'	MGD')	00039600
	WRITE(6,215) PBODIT			00039700
215	FORMAT(' EXPECTED BOD INFLUENT CONCENTRATION	:',F5.1,'	MG/L	00896000
	**)			00039900
103	RETURN			00040000
	END			00040100
-				00040200
с	THIS SUBROUTINE IS USED FOR PRINTING ALTERNATIVE SUBROUTINE SALT(IS,Q1IT,BOD1IT,Q2IT,BOD2IT,Q3IT,B	00317 0417		
	*)	00511,0111		00040500
	WRITE(6.201)			00040600
201	FORMAT(/1H0,' THIS IS YOUR ALTERNATIVE')			00040700
	GO TO (101,102,103,104,106,107,108,109),15			00040800
101	WRITE(6,105)			00040900
105	FORMAT(' TREAT EVERYTHING IN THE COMPANY PLANT &	RELEASE.')		00041000
	WRITE(6,115) QIIT			00041100
115	FORMAT(' TREATED WASTEWATER FLOW RATE WRITE(6,125) BODIIT	:',F7.3,'	MGD')	00041200
125	FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION			
125	*')	. , ,		00041500
	GO TO 325			00041600
102	WRITE(6,135)			00041700
135	FORMAT(' PRETREAT EVERYTHING IN THE COMPANY PLANT	& SEND TO		
	*NICIPAL PLANT.')			00041900
	WRITE(6,145) Q2IT			00042000
145		:',F7.3,'	MGD')	00042100
155	WRITE(6,155) BODZIT Format(' EXPECTED BOD EFFLUENT CONCENTRATION		MC /T	
	*')	. , ,		00042400
	GO TO 325			00042500
103	WRITE(6,165)			00042600
165	FORMAT(' SEND ALL WASTEWATER TO THE MUNICIPAL PLA	TUCHTIW TN	TREATM	100042700
	*ENT.)			00042800
	WRITE(6,175) Q3IT			00042900
175		:',F7.3,'	MGD')	00043000
185	WRITE(6,185) BOD3IT Format(' send Wastewater Bod Concentration	:',F5.1,'	MC /T	
105	*')	. , ,		00043300
	GO TO 325			00043400
104	WRITE(6,195)			00043500
195	FORMAT(' TREAT PART IN THE COMPANY PLANT & RELEAS	E, SEND TH	E OTHER	100043600
	* PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT.')			00043700
				00043800
205	FORMAT(' TREATED WASTEWATER FLOW RATE	:',F7.3,'	MGD')	00043900
215	WRITE(6,215) BODIIT FORMAT(' TREATED WASTEWATER BOD EFFLUENT CONCENTR	ATION		00044000 00044100
623	*',F5.1,' MG/L')	~		00044200
	WRITE(6,225) Q3IT			00044300
225	FORMAT(' WITHOUT TREATMENT WASTEWATER FLOW RATE	:'.F7.3.'	MGD')	00044400
	WRITE(6,235) BOD3IT			00044500
235	FORMAT(' WITHOUT TREATMENT WASTEWATER BOD EFFLUEN	T CONCENTR		
	*',F5.1,'MG/L')			00044700
	GO TO 325			00044800
106	WRITE(6,245)			00044900
245	FORMAT(' PRETREAT PART IN THE COMPANY PLANT & SE			
	*LANT, SEND THE OTHER PART WITHOUT TREATMENT TO TH *')	L RUNICIPA	E FLANT	00045100
	WRITE(6,255) Q2IT			00045300
255		: 7 . 3 . '	MGD')	
	WRITE(6,265) BOD2IT			00045500

265	FORMAT(' PRETREATED WASTEWATER BOD EFFLUENT CONCEN	NTRATION	:00045600
	*',F5.1,' MG/L')		00045700
	WRITE(6,275) 03IT	•	00045800
276	FORMAT(' WITHOUT TREATMENT WASTEWATER FLOW RATE		
2/3	WRITE(6,285) BODJIT	. ,. ,. ,,	00046000
285		CONCENTRA	
205	*',F5.1,' MG/L')	CONCENTRA	00046200
	GO TO 325		00046300
107	GO 10 325		00046300
205	PORMAN() DICAULDER (NAMUONA DEDVIA)		00046400
295	GO 10 25) WRITE(6,295) FORMAT(' DISCHARGE WITHOUT PERMIT') WRITE(6,305) Q4IT FORMAT(' DISCHARGED WASTEWATER FLOW RATE		00046500
	WRITE(B, JUS/ 0411		00046600
202	WRITE(6.315) BOD4IT	: , : / . 3 , '	MGD / 00046700
22.6			00046800
315	FORMAT(' DISCHARGED BOD EFFLUENT CONCENTRATION *')	1,12.1	
			00047000
	GO TO 325		00047100
	WRITE(6,335)		00047200
335	FORMAT (' TREAT, PART IN THE COMPANY PLANT & RELEASE	E, SEND THE	
	* PART WITHOUT TREATMENT TO THE RIVER.')		00047400
	WRITE(6,345) QIIT		00047500
345	FORMAT(' TREATED WASTEWATER FLOW RATE WRITE(6,355) BODIIT	. , . / , .	MGD 1 00047800
355			00047700
355	<pre>FORMAT(' TREATED WASTEWATER BOD EFFLUENT CONCENTRA *',F5.1,' MG/L')</pre>	ATION	:00047800 00047900
	WRITE(6,225) Q4IT		00047900
365	FORMAT(' DISCHARGED WASTEWATER FLOW RATE		
202	WRITE(6,375) BOD4IT	: ,:/.3,	00046200
375	FORMATI' DISCUNDEED UNSTEWNTER BOD EFFILIENT CONCEN	172 A TT ON	100048300
373	<pre>FORMAT(' DISCHARGED WASTEWATER BOD EFFLUENT CONCE) *',F5.1,'MG/L')</pre>	11401100	00048400
	GO TO 325		00048500
109	WRITE(6 385)		00048600
385	FORMAT(' DISCHARGE WITH PERMIT')		00048700
200	GO TO 325 WRITE(6,385) FORMAT(' DISCHARGE WITH PERMIT') WRITE(6,395) Q4IT FORMAT(' DISCHARGED WASTEWATER FLOW RATE WRITE(6,405) BOD4IT		00048800
395	FORMAT(' DISCHARGED WASTEWATER FLOW RATE	· . F7 . 3 '	MGD') 00048900
0.00	WRITE(6,405) BOD4IT	. ,,	00049000
405			
	*')	. ,,	00049200
325	RETURN		00049300
	END		00049400
			00049500
с	THIS SUBROUTINE IS USED FOR PRINTING UPGRADE PLAN SUBROUTINE SHUPGR(FQIT,FBODIT) WRITE(6.105)		00049600
	SUBROUTINE SHUPGR (FOIT, FBODIT)		00049700
	WRITE(6,105)		00049800
105	FORMAT(/1H0,' THIS IS YOUR UPGRADE PLAN')		00049900
	WRITE(6,105) Format(/1H0,' THIS IS YOUR UPGRADE PLAN') WRITE(6,115) FQIT Format(' Future design capacity		00050000
115	FORMAT(' FUTURE DESIGN CAPACITY	:'. #7.3.'	MGD') 00050100
••	WRITE(6,125) FBODIT		00050200
125	FORMAT(' FUTURE DESIGN BOD EFFLUENT CONCENTRATION	:',F5.1,'	MG/L00050300
	**)		00050400
	RETURN		00050500
	END		00050600

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APPENDIX F

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INTERACTIVE FORTRAN PROGRAM FOR PARTICIPANT INPUT

*** TSO FOREGROUND HARDCOPY **** JNAME=U11502C.SIMT.CNTL

THIS IS AN INTERACTIVE INPUT PROGRAM FOR STUDENTS. THE STUDENT HASO0000100 TO PROVIDE TEAM NUMBER (TEAM 1 TO 5 ARE INDUSTRIAL FIRMS, TEAM 6 00000200 AND 7 ARE MUNICIPAL TREATMENT PLANTS), PERIOD NUMBERS, BASIC 00000300 INFORMATIOM OF PRODUCTION VOLUME PRODUCED, WASTEWATER FLOW RATE 00000400 AND BOD CONCENTRATION. IF THE STUDENT WANTS TO BUY PERMITS, HE CANO0000500 ONLY CHOOSE ALTERNATIVE 1, 4, 7 OR ALTERNATIVE 8, IF HE WANTS TO 00000600 SELL PERMITS, HE CAN CHOOSE ANY ONE OF THESE EIGHT ALTERNATIVE TO 00000700 TREAT ITS WASTEWATER AND DECIDE WHETHER TO UPGRADE EXISTING PLANT 00000800 OR NOT IF THE STUDENT WANTS TO HEGADE THE PLANT THE UPGRADIA 00000900 TANGA IF THE STUDENT WARTS TO UPGRADE THE PLANT, THE UPGRADING 0000000 TAKES 2 PERIODS OF TIME. THIS PROGRAN WILL READ PLANT FILE AND TDP FILE.THE PROGRAM WILL 0000100 BE CREATED AS & LOAD MODULE AND EXECUTED BY TSO COMMAND LANGUAGE 00001200 (INPUTA.CLIST). 00001300 THE PROGRAM WILL GENERATE STUDENT DECISION FILE AND PLANT FILE. 00001400 THE STUDENT DECISION FILE WILL BE FED INTO MAIN PROGRAM AND INSTRUCTOR INPUT PROGRAM. THE PLANT FILE WILL BE FED INTO MAIN PROGRAM AND STUDENT INPUT PROGRAM LATER. 00001500 00001600 00001700 00001800 00001900 SQ(1) -> THE MAXIMUM LIMITATION OF WASTEWATER FLOW RATE TO THE 00002000 NUVER (MGD), TEAM 1 000022100 SBOD(1) -> THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO000022200 BED(1) -> THE RIVER (MG/L), TEAM OF BDD EFFDEEN CONCENTRATION DO002200 PBDD(1) -> WASTEWATER BOD CONCENTRATION PRODUCED (MG/L), FIRM I 00002200 PF(1) -> PRODUCTION FUNCTION OF INDUSTRIAL PRODUCT, FIRM I 00002500 RMBOD -> THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATON TO 00002500 THE MUNICIPAL TREATMENT PLANT (MG/L) 00002700 00002800 00002900 DIMENSION PR(7), PQ(7), PBOD(7), DQ(7), DBOD(7), FQ(7), FBOD(7), Q1(7), 00003000 BOD1(7), Q2(7), BOD2(7), Q3(7), BOD3(7), Q4(7), BOD4(7), U02(7)00003100 UBOD1(7), J:F(7), SQ(7), SBOD(7), PF(7), CBOD(7) 00003200 00003200 00003300 CHARACTER*1 AR DATA SQ/1.7.0.38.0.03.0.04.2..26.7.5.6/ DATA SBOD/30.24.40..20.20.45.10./ DATA PBOD/200.300.400.100.400.0.0.0/ DATA PF/0.484.0.1212.0.0379.0.1569.0.0379.0.0./ 00003400 00003600 00003700 DATA RMBOD/400./ 00003900 00004000 READ TRADING NUMBER PERMITS OF EACH TEAM READ(9,107) (IF(I),TDP(IF(I)),I=1,7) FORMAT(I2,1X,F10.2) 00004100 00004200 107 00004300
 00004300
 00004300

 READ CURRENT DESIGN CAPACITY AND DESIGN BOD EFFLUENT CONCENTRAION 00004400
 00004400

 READ(10,115,END=101) I,DQ(I),DBOD(I)
 00004500

 FORMAT(I2,1X,F6.3,F5.1)
 00004600
 14 115 GO TO 114 DO 116 I=1,7 00004700 - 01 00004800 PQ(I)=0. 00004900 .16 CONTINUE 00005000 SBCD(1)=30. SBOD(2)=24. 00005100 SBOD(3)=40. 00005300 SBOD(4)=20. SBOD(5)=20. 00005400 00005500 SBOD(6)=45. 00005600 SBOD(7)=10 00005700 MFLG AND INFLG ARE FLAGS TO CONTROL SWITCH 00005800

MFLG--1

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	INFLG=-1	00006000
	1S=0	00006100 00006200
		00006300
с	INPUT BASIC INFORMATION FOR THE SIMULATION GAME	00006400
100	PRINT 123 Format(1x,'Please enter your region (e.g. a, b or c)')	00006500
123		00006600
124	READ(5,124) AR Format(Al)	00006700
124	PRINT 125	00006800
125	FORMAT(1X, 'PLEASE ENTER YOUR TEAM NUMBER AGAIN (E.G. 1)')	00006900
125	READ*, IT	00007000
	PRINT 135	00007100
135	FORMAT(1X, 'PLEASE ENTER YOUR PERIOD NUMBER AGAIN (E.G. 1)')	00007200
100	READ*, IP	00007300
	CALL INTALT(IFLAG,Q1(IT),BOD1(IT),Q2(IT),BOD2(IT),Q3(IT),BOD3(IT)	
	*Q4(IT), BOD4(IT), UQ1(IT), UBOD1(IT), FQ(IT), FBOD(IT))	00007500
	IF (IT.LE.5) GO TO 201	00007600
	IF (IT.GT.5) GO TO 202	00007700
201	IJ=1	00007800
	PRINT 145	00007900
145	FORMAT(1X,'INDUSTRIAL FIRM')	0008000
91	PRINT 155	00008100
155	FORMAT(1%, 'ENTER YOUR PRODUCTION FORCAST')	00008200
	READ*, PR(IT)	00008300
	PQ(IT)=PR(IT)*PF(IT)	00008400
	PRINT 165, PQ(IT)	00008500
165	FORMAT(12, 'EXPECTED WASTEWATER FLOW RATE :', F7.3, 'MGD')	00008600
	PRINT 175, PBOD(IT)	00008700
175	FORMAT(1X, 'EXPECTED BOD INFLUENT CONCENTRATION :', F5.1, ' MG/L')	00008900
185	PRINT 185 Format(1x,'do you want to try another production level')	00009000
100	CALL YESNO(IA)	00009100
	IF (IA.EQ.1) GO TO 91	00009200
	IF (IA.EQ.2) GO TO 210	00009300
с	IA.EQ.1> YES, IA.EQ.2> NO	00009400
202	IJ=2	00009500
	PRINT 140	00009600
140		00009700
	PRINT 150	00009800
150	FORMAT(1X, 'ENTER YOUR RESIDENTIAL WASTEWATER FLOW RATE (MGD)')	00009900
	READ*,UQ1(IT)	00010000
	PRINT 160	00010100
160		R00010200
	*ATION (MG/L)')	00010300
	READ*, UBOD1(IT)	00010400 00010500
	CALL MPEBOD(DBOD(IT), CBOD(IT), SBOD(IT))	
210	CALL INFO(AR, IT, IJ, IP, PR(IT), DQ(IT), DBOD(IT), PQ(IT), PBOD(IT), UQ1(00010700
102	*T),UBOD1(IT),TDP(IT),SBOD(IT),CBOD(IT)) PRINT 195	00010800
195	FORMAT(1X, DO YOU WANT TO SELECT AN ALTERNATIVE FOR DISPOSING OF	C00010900
195	*URRENT PERIOD WASTEWATER OR UPGRADING EXISTING PLANT')	00011000
	PRINT 196	00011100
196	FORMAT('OR CORRECT SOME INFORMATION')	00011200
	CALL YESNO(IA)	00011300
	IF ((IA,EQ.2).AND.(IJ,EQ.2)) GO TO 765	00011400
	IF (IA.EO.2) GO TO 501	00011500
с	FLAG FOR MUNICIPAL TREATMENT PLANT EFFECTIVE FOR 190 FORMAT	00011600
	IF (MFLG.50.0) GO IO IBO	00011700
. C	FLAG FOR INDUSTRIAL FIRM EFFECTIVE FOR 265 FORMAT	00011800
	IF (INFLG.EQ.0) GO TO 255	00011900
	PRINT 215	00012000
c	ASK FOR ANY CORRECTION ?	00012100
215	FORMAT(12, 'IS THE INFORMATION SHOWN ABOVE CORRECT?')	00012200
	CALL CORT(IC)	00012300
	IF (IJ.EQ.1) GO TO 103	00012400
	IF (IC.EQ.1) GO TO 735	00012500

00005900

	IF (IC.EQ.2) GO TO 180	00012600
		00012700
	MAKE CORRECTION FOR THE MUNICIPAL TREATMENT PLANT	00012800
180	PRINT 190	00012900
190	FORMAT (' TYPE VARIABLE NUMBER TO BE CHANGED OR -1 TO LIST THE INFO	
	*RMATION YOU HAVE')	00013100
	PRINT 200	00013200
200	FORMAT(' FOR EXAMPLE: TYPE 2 FOR PERIOD NUMBER')	00013300
	READ*, MFLG	00013400
	IF (MFLG.GE.0) GO TO 205	00013500 00013600
	MFLG=0	00013700
	GO TO 210 IN=MFLG	00013800
205		00013900
	GO TO (285,295,225,235,245),IN PRINT 260,IN	00014000
260	FORMAT(' WARNING:', 12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT /	
200	* REASONABLE VALUE')	00014200
	GO TO 180	00014300
325	PRINT 150	00014400
	READ*, UQ1(IT)	00014500
	CALL CORT(IB)	00014600
	IF (IB.EQ.1) GO TO 210	00014700
	IF (IB.EQ.2) GO TO 180	00014800
235	PRINT 160	00014900
	READ*, UBOD1(IT)	00015000
	CALL CORT(IB)	00015100
	IF (IB.EQ.1) GO TO 210	00015200
	IF (IB.EQ.2) GO TO 180	00015300
245	CALL MPEBOD(DBOD(IT), CBOD(IT), SBOD(IT))	00015400 00015500
	CALL CORT(IB)	00015600
	IF (IB.EQ.1) GO TO 210 IF (IB.EO.2) GO TO 180	00015700
103	IF (IC.EQ.1) GO TO 495	00015800
100	IF (IC.EQ.2) GO TO 255	00015900
		00016000
	MAKE CORRECTION FOR THE INDUSTRIAL FIRM	00016100
255	PRINT 265	00016200
265	FORMAT(' TYPE VARIABLE NUMBER TO BE CHANGED OR -1 TO LIST THE INFO	
	*RMATION YOU HAVE')	00016400
	PRINT 275	00016500
275	FORMAT(' FOR EXAMPLE: TYPE 3 FOR PRODUCTION FORCAST')	00016600
	READ*, INFLG	00016700 00016800
	IF (INFLG.GE.O) GO TO 266 INFLG=0	00016900
	GO TO 210	00017000
266	IN=INFLG	00017100
200	GO TO (285,295,305),IN	06017200
	PRINT 260.IN	00017300
	GO TO 255	00017400
285	PRINT 125	00017500
	READ*, IT	00017600
	CALL CORT(IB)	00017700
	IF (IB.EQ.1) GO TO 210	00017800
	IF ((IB.EQ.2).AND.(IJ.EQ.1)) GO TO 255	00017900
	IF ((IB.EQ.2).AND.(IJ.EQ.2)) GC TO 180	00018000
295	PRINT 135	00015100
	READ*, IP	00018200
	CALL CORT(IB)	00018300
	IF (IB.EQ.1) GO TO 210	00018400
	IF ((IB.EQ.2).AND.(IJ.EQ.1)) GO TO 255	00018500 00018600
305	IF ((IB.EQ.2).AND.(IJ.EQ.2)) GO TO 180 PRINT 155	00018700
205	READ*, PR(IT)	00018800
	PO(IT) = PR(IT) * PF(IT)	00018900
	CALL CORT(IB)	00019000
	IF (IB.EQ.1) GO TO 210	00019100

	IF (IB.EQ.2) GO TO 255 00019200
с	00019300
495	SELECT ALTERNATIVE FOR DISPOSING WASTEWATER 00019400 PRINT 505 00019500
505	FORMAT(/1X,'SELECT ALTERNATIVE FOR DISPOSING OF CURRENT PERIOD WAS00019600
	*TEWATER - ENTER NUMBER') 00019700
162	CALL INTALT(IFLAG, 01(IT), BOD1(IT), 02(IT), BOD2(IT), 03(IT), BOD3(IT), 00019800
~	*Q4(IT),BOD4(IT),UQ1(IT),UBOD1(IT),FQ(IT),FBOD(IT)) 00019900
с	PRINT LIST OF ALTERNATIVES 00020000 PRINT 515 00020100
515	FORMAT(1X,'1 TREAT EVERYTHING IN THE COMPANY PLANT & RELEASE.') 00020200
010	PRINT 525 00020300
525	FORMAT(1X,'2 PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THO0020400
	*E MUNICIPAL PLANT.') 00020500
	PRINT 535 00020600
535	FORMAT(1X,'3 SEND ALL WASTE TO THE MUNICIPAL PLANT WITHOUT TREATME00020700 *NT.') 00020800
	PRINT 555 00020900
555	FORMAT(1X,'4 TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE 000021000
	*THER PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT.') 00021100
	PRINT 565 00021200
565	FORMAT(1X,'5 PRETREAT PART IN THE COMPANY PLANT LSEND TO MUNICIPAL00021300
	* PLANT, SEND THE OTHER PART WITHOUT TREATMENT TO THE MUNICIPAL PLA00021400 *NT.') 00021500
	PRINT 574 00021600
574	FORMAT(1X, '6 DISCHARGE WITHOUT PERMIT.') 00021700
	PRINT 575 00021800
575	FORMAT(1X,'7 TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE 000021900
	*THER PART WITHOUT TREATMENT TO THE RIVER.') 00022000
576	PRINT 576 00022100 FORMAT(1X,'8 DISCHARGE WITH PERMIT.') 00022200
5.0	PRINT 577 00022300
577	FORMAT(1X, IF YOU BUY PERMITS, YOU CAN ONLY CHOOSE ALTERNATIVE 1,400022400
	*, 7 OR ALTERNATIVE 8') 00022500
	PRINT 578 00022600
5/8	FORMAT(1X,'IF YOU SELL PERMITS, YOU CAN CHOOSE ANY ONE OF THESE 5100022700 *X ALTERNATIVES') 00022800
	READ*, IS 00022900
	GO TO (585,595,605,615,625,635,665,666),15 00023000
	PRINT 645, IS 00023100
645	FORMAT(' WARNING:', 12,' EXCEEDS THE BOUNDARY VALUE PLEASE CORRECT00023200
	* YOUR ALTERNATIVE') C0023300 GO TO 495 D0023400
585	GO TO 495 CALL TECP(IFLAG,DQ(IT),DBOD(IT),PQ(IT),PBOD(IT),SQ(IT),SBOD(IT),Q100023500
	*(IT), BOD1(IT), TDP(IT)) 00023600
	IF (IFLAG.EQ.1) GO TO 495 00023700
	GO TO 655 00023800
595	CALL PESM(IFLAG, DQ(IT), DBOD(IT), PQ(IT), PBOD(IT), RMBOD, Q2(IT), BOD2(00023900
	*IT),TDP(IT)) 00024000 IF (IFLAG.EQ.1) GO TO 495 00024100
	IF (IFLAG.EQ.1) GO TO 495 00024100 GO TO 655 00024200
605	CALL SEMP(IFLAG, PQ(IT), PBOD(IT), Q3(IT), BOD3(IT), TDP(IT), RMBOD) 00024300
	IF (IFLAG.EQ.1),GO TO 495 00024400
• • • • •	GO TO 655 00024500
615	CALL TPCWM(IFLAG, DQ(IT), DBOD(IT), PQ(IT), PBOD(IT), SQ(IT), SBOD(IT), 200024600
	*1(IT),BOD1(IT),Q3(IT),BOD3(IT),TDP(IT)) 00024700 IF (IFLAG.EQ.1) GO TO 495 00024800
	GO TO 655 00024900
625	CALL PPCWM(IFLAG, DQ(IT), DBOD(IT), PQ(IT), PBOD(IT), RMBOD, Q2(IT), BOD200025000
	*(IT),Q3(IT),BOD3(IT),TDP(IT)) 00025100
	IF (IFLAG.EQ.1) GO TO 495 00025200
635	GO TO 655 00025300
022	CALL WDUMP(IFLAG,PQ(IT),PBOD(IT),Q4(IT),BOD4(IT),TDP(IT)) 00025400 IF (IFLAG.EQ.1) GO TO 495 00025500
	IF (IFLAG.EQ.1) GO TO 495 00025500 GO TO 655 00025600
665	CALL TPSR (IFLAG, DQ(IT), DBOD(IT), PQ(IT), PBOD(IT), SQ(IT), SBOD(IT), Q00625700

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	*1(IT), BOD1(IT), Q4(IT), BOD4(IT), TDP(IT))	00025800
	IF (IFLAG.EQ.1) GO TO 495	00025900
	GO TO 655	00026000
666	CALL WPDUMP(IFLAG, PQ(IT), PBOD(IT), Q4(IT), BOD4(IT), TDP(IT))	00026100
	IF (IFLAG.EQ.1) GO TO 495	00026200
ó55	_CALL_SALT(IS,Q1(IT),BOD1(IT),Q2(IT),BOD2(IT),Q3(IT),BOD3(IT),Q4(IT)	
	*),BOD4(IT))	00026400
	PRINT 675	00026500
o75	FORMAT(1X,'IS THIS CORRECT')	00026600
161	PRINT 685	00026700
685	FORMAT(1X, 'ENTER 1 IF CORRECT')	00026800
ő95	PRINT 695	00026900
695	FORMAT(1X,'ENTER 2 IF WANT TO DELETE CHOSEN ALTERNATIVE AND SELEC: * ANOTHER ALTERNATIVE')	
	READ*, IC	00027100
	IF (IC.EQ.1) GO TO 735	00027300
	IF (IC.EQ.2) GO TO 715	00027400
	PRINT 705,IC	00027500
705	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT)	
	* REASONABLE VALUE')	00027700
	GO TO 161	00027800
715	PRINT 725	00027900
725	FORMAT(1X,'ENTER ALTERNATIVE NUMBER TO BE SELECTED')	00028000
	GO TO 162	00028100
		00026200
	DECIDE TO UPGRADE EXISTING PLANT	00028300
735	PRINT 745	00028400
745	FORMAT(1X, 'DO YOU WANT TO UPGRADE EXISTING PLANT')	00028500
	CALL YESNO(IA) IF (IA.EQ.2) GO TO 765	00028600
	CALL UPGRAD(IFLAG, DQ(IT), DBOD(IT), FQ(IT), FBOD(IT), SQ(IT), SBOD(IT))	00028700
765	CALL INFO(AR, IT, IJ, IP, PR(IT), DQ(IT), DBOD(IT), PQ(IT), PBOD(IT), UQ1()	
	*T), UBOD1(IT), TDP(IT), SBOD(IT), CBOD(IT))	00029000
	IF (IJ.EQ.2) GO TO 104	00029100
	CALL SALT(IS,Q1(IT),BOD1(IT),Q2(IT),BOD2(IT),Q3(IT),BOD3(IT),Q4(IT)	
	*), BOD4(IT))	00029300
104	IF (IA.EQ.2) GO TO 775	00029400
	IF (IFLAG.EQ.1) GO TO 775	00029500
	CALL_SHUPGR(FQ(IT),FBOD(IT))	00029600
775	PRINT 785	00029700
785	FORMAT(' THIS WILL BE STORED AS YOUR DECISION FOR THIS PERIOD IN A	
	* DATA FILE.') PRINT 795	00029900
795		00030000
.95	FORMAT(' IF YOU WANT TO INPUT ALL THE DATA AGAIN, PLEASE TYPE -1 (*THERWISE TYPE 0')	00030200
	READ*, IFLG	00030300
	IF (IFLG.GE.0) GO TO 805	00030400
	GO TO 101	00030500
		00030600
	PRINT OUTPUT FOR STUDENT DECISION FILE	00030700
305	WRITE(11,50) AR, IT, IJ, IS, IP, PR(IT), PQ(LT), PBOD(IT), Q1(IT), BOD1(IT)	00030800
	*,Q2(IT),BOD2(IT),Q3(IT),BOD3(IT),Q4(IT),BOD4(IT),UQ1(IT),UBOD1(IT)	00030900
	*,FQ(IT),FBOD(IT),SBOD(IT),CBOD(IT)	00031000
50	FORMAT(A1,411,F6.3,6(F6.3,F5.1)/F6.3,3F5.1)	00031100
	IF(FQ(IT).LE.0) GO TO 815	00031200
	PTINT OUTPUT FOR PLANT FILE	00031300
207	WRITE(20,806) IT, $FQ(IT)$, $FBOD(IT)$	00031400
306	FORMAT(12,1X,F6.3,F5.1)	00031500
815	GO TO 501 WRITE(20,806) IT,DQ(IT),DBOD(IT)	00031600 00031700
501	STOP	00031800
201	END	00031900
		00032000
•	THIS SUBROUTINE IS USED FOR INITIALIZATION	00032100
	SUBROUTINE INTALT (LFLAG, Q1IT, BOD1IT, Q2IT, BOD2IT, Q3IT, BOD3IT, Q4IT, F	
	*OD4IT, UQ1IT, UBODIT, FQIT, FBODIT)	00032300
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	IFLAG=0		00032400
	QIIT=0.		00032500
	BODIIT=0.		00032600
	Q2IT=0.		00032700
	BOD2IT=0.		00032800
	Q31T=0.		00032900
	BOD3IT=0.		00033000
	Q4IT=0.		00033100
	BOD4IT=0.		00033200
	UOIIT=0.		00033300
	UBODIT=0.		00033400
	FQIT=0.		00033500
	FBODIT=0.		00033600
	RETURN		00033700
	END		00033800
			00033900
ç	THIS SUBROUTINE IS USED FOR SELECTING MUNICIN	PAL PLANT WASTEWATER	
с	OD EFFLUENT CONCENTRATION		00034100
	SUBROUTINE MPEBOD (DBODIT, CBODIT, SBODIT)		00034200
	PRINT 105, DBODIT		00034300
105	FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTI	RATION	00034400
	* :',F5.1,' MG/L')		00034500
	PRINT 115, SBODIT		00034600
115	FORMAT(' THE MAXIMUM LIMITATION OF BOD EFFLU	ENT CONCENTRATION TO	
	*HE RIVER :',F5.1,' MG/L')		00034800
155	PRINT 125		00034900
125	FORMAT(1X, 'ENTER EXPECTED BOD EFFLUENT CONCE	NTRATION (MG/L)')	00035000
	READ*, CBODIT		00035100
С	SHOW RESTRICTION ITEMS		00035200
	IF (CBODIT.GE.DBODIT) GC TO 135		00035300
	PRINT 145, CBODIT, DBODIT		00035400
145	FORMAT(' WARNING: TREATED BOD EFFLUENT CONCEN		
	*OWERS THE DESIGN BOD EFFLUENT CONCENTRATION'	,F5.1,'MG/L')	00035600
	GO TO 155		00035700
135	IF (CEODIT,LE.SEODIT) GO TO 165		00035800
	PRINT 175, CBODIT, SBODIT		00035900
175	FORMAT(' WARNING: TREATED BOD EFFLUENT CONCEN	NTRATION', F5.1, 'MG/L	E00036000
	*XCEED THE ALLOWED BOD EFFLUENT CONCENTRATION	',F5.1,'MG/L')	00036100
165	RETURN		00036200
	END		00036300
			00036400
С	THIS SUBROUTINE IS USED FOR PRINTING BASIC IN	NFORMATION	00036500
	SUBROUTINE INFO(AR, IT, IJ, IP, PRIT, DQIT, DBODIT	, PQIT, PBODIT, UQLIT, UI	
	*DIT, TDPIT, SBODIT, CBODIT)		00036700
	PRINT 105		00036800
105	FORMAT(1X, 'THIS IS THE INFORMATION YOU HAVE')	00036900
	PRINT 114, AR		00037000
114	FORMAT(1X,' REGION	:',1X,Al)	00037100
	PRINT 115,IT		00037200
115	FORMAT(1X,'1,TEAM NUMBER	:',12)	00037300
	PRINT 125, IP		00037400
125	FORMAT(1X,'2.PERIOD NUMBER	:',12)	00037500
	PRINT 135, DQIT		00037600
135	FORMAT(1X, 'CURRENT DESIGN CAPACITY	:',F7.3,'MGD')	00037700
	PRINT 145, DEODIT		00037800
145	FORMAT(1X, 'CURRENT DESIGN BOD EFFLUENT CONCE	NTRATION :'.F5.1.'MG.	/L00037900
	*')		00038000
	PRINT 146, SBODIT		00038100
146	FORMAT(12, 'CURRENT MAXIMUM LIMITATION OF BOD	EFFLUENT CONCENTRAT	000038200
	*N TO THE RIVER: ', F6.1, 'MG/L')		00038300
	IF (TDPIT) 104,106,107		00038400
104	PRINT 147, ABS(TDPIT)		00038500
147	FORMAT(1X, 'NUMBER OF PERMITS SOLD	:'.F6.2)	00038600
	GO TO 106		00038700
107	PRINT 148, TDPIT		00038800
148	FORMAT(1X, 'NUMBER OF PERMITS BOUGHT	;',F6.2)	00038900
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 16 (IJ.GT.1) GO TO 101 PRINT 155 155 FORMAT(1X,' THIS IS INDUSTRIAL FIRM') GO TO 102 101 PRINT 165 165 FORMAT(1X,' THIS IS MUNICIPAL TREATMENT PLANT') PRINT 175,UQ1IT 175 FORMAT(1X,'3.EXPECTED RESIDENTIAL WASTEWATER FLOW RATE 	00039000
PRINT 155	00039100
155 FORMAT(1X,' THIS IS INDUSTRIAL FIRM')	00039200
GO TO 102	00039300
101 PRINT 165	00039400
165 FORMAT(1X,' THIS IS MUNICIPAL TREATMENT PLANT')	00039500
PRINT 175, UQ11T	00039600
.75 FORMAT(1X, '3.EXPECTED RESIDENTIAL WASTEWATER FLOW RATE	00039700
- :,F/.3, MGD /	00039800
PRINT 185, UBODIT	00039900
.85 FORMAT(1X,'4.EXPECTED RESIDENTIAL WASTEWATER BOD INFLUENT CONCENT *ATION :',F5.1,'MG/L')	
	00040100
PRINT 186,CBODIT 186 FORMAT(1X,'5.EXPECTED MUNICIPAL PLANT WASTEWATER BOD EFFLUENT CON	00040200
*ENTRATION ;', F5.1, 'MG/L')	00040400
GO TO 103	00040500
102 PRINT 195, PRIT	00040600
95 FORMAT(1X, '3. PRODUCTION FORCAST :', F7. 3)	00040700
PRINT 205, PQIT	00040800
105 FORMAT(1X,' EXPECTED WASTEWATER FLOW RATE :',F7.3,'MGD')	00040900
PRINT 215, PBODIT	00041000
<pre>115 FORMAT(1X,' EXPECTED BOD INFLUENT CONCENTRATION :',F5.1,'MG.</pre>	
+L')	00041200
103 RETURN	00041300
END	00041400
	00041500
THIS SUBROUTINE IS USED FOR ALTERNATIVE "TREAT EVERYTHING IN THE	00041600
COMPANY PLANT AND RELEASE"	00041700
SUBROUTINE TECP(IFLAG, DQIT, DBODIT, PQIT, PBODIT, SQIT, SBODIT, QIIT, BO	
*1IT,TDPIT)	00041900
IFLAG=0	00042000
SHOW BASIC INFORMATION	00042100
PRINT 105	00042200
105 FORMAT(' TREAT EVERYTHING IN THE COMPANY PLANT & RELEASE.') PRINT 115,DQIT	00042300
-15 FORMAT(' CURRENT DESIGN CAPACITY :',F7.3,'MGD')	00042400
PRINT 125, DBODIT	00042600
.25 FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :',F5.1,' MG/1	
	00042800
IF (TDPIT) 126,127,128	00042900
	00043000
129 FORMAT(' NUMBER OF PERMITS SOLD :',F6.2)	00043100
GO TO 127	00043200
128 PRINT 130, TDPIT	00043300
_30 FORMAT(' NUMBER OF PERMITS BOUGHT :', F6.2)	00043400
127 PRINT 135, PQIT	00043500
.35 FORMAT(' EXPECTED WASTEWATER FLOW RATE :',F7.3,'MGD')	
PRINT 145, PBODIT	00043700
.45 FORMAT(' EXPECTED BOD INFLUENT CONCENTRATION :',F5.1,' MG/1	00043800
**)	00043900
PRINT 146,SQIT 146 FORMAT(' THE MAXIMUM LIMITATION OF WASTEWATER FLOW RATE TO THE RIV	00044000
<pre>146 FORMAT(' THE MAXIMUM LIMITATION OF WASTEWATER FLOW RATE TO THE RI' *ER :',F7.3,'MGD')</pre>	
PRINT 147, SBODIT	00044200 00044300
	00044300
47 FORMATIC THE MAXIMUM LIMITATION OF BOD FEELDENT CONCENTRATION TO "	00044400
.47 FORMAT(' THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO ' *HE RIVER :'.F5.1.' MG/L')	
*HE RIVER :',F5.1,' MG/L')	00044500
*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS	00044500 00044600
*HE RIVER :',F5.1,' MG/L') Show restriction items IF (PQIT.LE.DQIT) GO TO 160	00044500 00044600 00044700
*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (PQIT.LE.DQIT) GO TO 160 PRINT 155.PQIT.DQIT	00044500 00044600 00044700 00044800
*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (PQIT.LE.DQIT) GO TO 160 PRINT 155,PQIT.DQIT 255 FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE',F9.5,'MGD EXCEEDS	00044500 00044600 00044700 00044800 00044800
*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (PQIT.LE.DQIT) GO TO 160 PRINT 155.PQIT.DQIT	00044500 00044600 00044700 00044800 00044900 00044900
<pre>*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (PQIT.LE.DQIT) GO TO 160 PRINT 155.PQIT.DQIT 155 FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE',F9.5,'MGD EXCEEDS *THE DESIGN CAPACITY',F9.5,'MGD') PRINT 156</pre>	00044500 00044600 00044700 00044800 00044900 00045000 00045000
<pre>*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (PQIT.LE.DQIT) GO TO 160 PRINT 155,PQIT.DQIT 155 FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE',F9.5,'MGD EXCEEDS *THE DESIGN CAPACITY',F9.5,'MGD') PRINT 156 56 FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIL</pre>	00044500 00044600 00044700 00044800 00044900 00045000 00045000
<pre>*HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (PQIT,LE.DQIT) GO TO 160 PRINT 155.PQIT,DQIT 255 FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE',F9.5,'MGD EXCEEDS *THE DESIGN CAPACITY',F9.5,'MGD') PRINT 156</pre>	00044500 00044600 00044700 00044800 00044800 00045000 00045100
 *HE RIVER :',F5.1,' MG/L') SHOW RESTRICTION ITEMS IF (POIT.LE.DQIT) GO TO 160 PRINT 155, POIT.DQIT \$55 FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE',F9.5,'MGD EXCEEDS *THE DESIGN CAPACITY',F9.5,'MGD') PRINT 156 \$60 FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSII *ER ALTERNATIVE 3,4,5,6') 	00044500 00044600 00044700 00044800 00044900 00045000 00045200 00045200

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	PRINT 157, PQIT, SQIT	00045600
157	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE', F9.5, 'MGD EXCEEDS	00045700
	*THE MAXIMUN LIMITATION OF WASTEWATER FLOW RATE TO THE RIVER', F9.5,	00045800
	*'MGD')	00045900
	PRINT 156	00046000
	GO TO 102	00046100
164	CALL YESNO(IA)	00046200
	IF (IA.EQ.2) GO TO 102	00046300
175	QlIT=PQIT	00046400
С	PERMIT SOLD IS NEGATIVE SIGN IN THE INPUT FILE	00046500
101	BODIIT=(SBODIT=SQIT)/QIIT+TDPIT/8.34	00046600
ç	GET INPUT DATA	00046700
с	PRINT 185	00046800
C185	FORMAT(1X, 'ENTER DESIRED BOD EFFLUENT CONCENTRATION (MG/L)')	00046900
С	READ*, BODIIT	00047000
	PRINT 100	00047100
100	FORMAT(1X, 'THIS IS YOUR ALTERNATIVE')	00047200
1.05	PRINT 195,QIIT	00047300
195	FORMAT(1X, 'TREATED WASTEWATER FLOW RATE :', F7.3, 'MGD')	00047400
205	PRINT 205, BODIIT	00047500
c ²⁰⁵	FORMAT(1x, 'EXPECTED BOD EFFLUENT CONCENTRATION :', F5.1, ' MG/L')	00047600
L107	MAKE CORRECTION .	00047700
215	PRINT 215 Format(' is this correct')	00047800
103	PRINT 225	00047900
225	FORMAT(' ENTER 1 IF CORRECT')	00048000
225	PRINT 235	00048200
235	FORMAT(' ENTER 2 IF WANT TO CHANGE BOD EFFLUENT CONCENTRATION')	00048300
	PRINT 245	00048400
245	FORMAT(' ENTER 3 IF WANT TO SELECT DIFFERENT ALTERNATIVE')	00048500
210	READ*, IC	00048600
	GO TO (265,175,102),IC	00048700
	PRINT 255,IC	00048800
255	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT /	
	* REASONABLE VALUE')	00049000
	GO TO 103	00049100
102	IFLAG=1	00049200
	QlIT=0.	00049300
	BODIIT=0.	00049400
	GO TO 335	00049500
305	QliT=FLG	00049600
	GO TO 101	00049700
265	IF (QLIT.LE.DQIT) GO TO 335	00049600
	PRINT_325,QIIT,DQIT	00049900
325	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE ', F7.3, 'MGD EXCEEDS	
	*THE DESIGN WASTEWATER CAPACITY ', F7.3, 'MGD')	00050100
220	PRINT 326	00050200
326	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO SELECT D	
	*FFERENT ALTERNATIVE')	00050400
	READ*, FLG	00050500
	IF (FLG.GE.0.) GO TO 305 GO TO 102	00050600
335	RETURN	00050800
555	END	00050900
		00051000
с	THIS SUBROUTINE IS USED FOR ALTERNATIVE "PRETREAT EVERYTHING IN	00051100
č	THE COMPANY PLANT & SEND TO THE MUNICIPAL TREATMENT"	00051200
-	SUBROUTINE PESM(IFLAG, DQIT, DBODIT, PQIT, PBODIT, RMBOD, Q2IT, BOD2IT, TI	
	*PIT)	00051400
	IFLAG=0	00051500
	PRINT 105	00051600
105	FORMAT(' PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE MI	00051700
	*NICIPAL PLANT.')	00051800
	IF (TDPIT.LE.G.) GO TO 104	00051900
	PRINT 114,TDPIT	00052000
114	FORMAT(' NUMBER OF PERMITS BOUGHT IS', F5.0, 'SORRY THIS IS INFEASIN	300052100

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04 PRIM 15 FORM PRIM 25 FORM *') 37 FORM PRIM 57 FORM *FORM *'1 PRI	BASIC INFORMATION 00652 '115,DOT 00652 '125,DBODIT 00652 '125,DBODIT 0052 '125,DBODIT 0052 '135,PQIT 0052 '135,PQIT 0053 '135,PQIT 0053 '135,PQIT 0053 '135,PQIT 0053 '145,PBODIT 0053 '145,PBODIT 0053 '145,PBODIT 00053 '146,PBODIT 00053 '141,PEATMENT PLANT :',F5.1,' MG/L') 00054 '150,PQIT,DQIT 00054 '151,PQIT,DQIT 00054 '162,PQIT,DQIT 00054 '162,RMBOD GO TO 164 00054 '162,RMBOD,BODIT 0054 '164 00054 '164 00054 '162,RMBOD GO TO 1
04 PRIM 15 FORMU 15 FORMU 15 FORMU 10 135 FORMU 15 15 FORMU 16 16 17 16 17 17 17 17 17 17 17 17 17 17	<pre>'li5.poT</pre>
PRIM PRIM *') PRIM *') PRIM *') PRIM *' PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A *'A PRIM *'A	125,DBODIT 00652 CT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L0052 0053 115,POIT 0053 146,PBODIT 0053 146,RMBOD 0051 116,PHODIT 0053 146,RMBOD 0053 116,PHODIT 0053 116,PHODIT 0053 116,PHODIT 0053 116,PHODIT 0053 116,RMBOD 00053 116,RMBOD 00053 116,PANDOTIT 0054 0017,THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO TOUDOS3 NICIPAL TREATMENT PLANT :',F5.1,' MG/L') 00053 0017,LE.DOIT') GO TO 161 00053 '156,DOIT,DOIT' 00054 1017,CE.DOIT') GO TO 161 00054 '163 00054 102 00054 102 00054 103 0014 104 00054 1051 0054 1062 0054 1064 0054 1065 0054 1065 0054 1062 0055
25 FORMU *') PRIN: 5 FORMU *15 FORMU *17 *16 FORMU *16 FORMU *17 *16 FORMU *17 PRIN: 55 FORMU *16 FORMU *16 FORMU *17 FORU	T(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :',F5.1,' MC/L0052 '135,POIT 00053 '145,PBODIT 00053 '146,RMBOD 00053 '146,RMBOD 00053 '146,RMBOD 00053 '1416,RMBOD 00053 '1416,RMBOD 00053 '1410,RENTRENT FLANT:',F5.1,' MG/L') 00053 '1410,RESTRICTION ITEMS 00053 '1510,DOIT 00054 '1510,CAPACITY,F9.5,'MGD') 00053 '1516,DOIT,DOIT 00054 '1516,OGN CAPACITY,F9.5,'MGD') 00054 '1516 SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIDUOS4 '152,C2,RMBOD,DBODIT 00054 '163 00055 '163 00055 '163 00055 '164 SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDERO055 '163
35 FORMJ PRIN* FORMJ *1) PRIN* *46 FORMJ *16 FORMJ *2 FORMJ *3 FORMJ *4 ALT *4 FORMJ *5 FORMJ *5 FORMJ	<pre>'135.PQIT 00053 '145.PQDIT ', EXPECTED WASTEWATER FLOW RATE ', F7.3, 'MGD') 00053 '145.PGDDIT ', 'F7.3, 'MGD') 00053 '145.PGDDIT ', 'F7.1, 'MGD') 00053 '146.RMBOD ', 'F7.1, 'MGD') 00053 '146.RMBOD ', 'F7.1, 'MGD') 00053 '146.RMBOD ', 'F7.1, 'MGD') 00053 '155.PQIT 00054 '155.PQIT 00054 '155.PQIT 00054 '156.PQIT 00054 '156 'SGRY THIS IN FEASIBLE SOLUTION, PLEASE CONSIDUOS4 '162 NOT 164 ', 'SORRY THIS IN FEASIBLE SOLUTION, PLEASE CONSIDUOS5 'I(' SORRY THIS IN FEASIBLE SOLUTION, PLEASE CONSIDUES5 'I(A) 00055 'I(A) 00055</pre>
45 FORM *)) PRIN 46 FORM *RE M SHOW IF (1) PRIN *RE DI PRIN *RE DI PRIN *GO T GO T GO T GO T GO T GO T GO T GO T GO T SFORM *LE PRIN *LE PRIN *IF GO T GO T GO T GO T SFORM *LE SFOR *LE SFORM *LE SF	T(' EXPECTED BOD INFLUENT CONCENTRATION :',F5.1,' MG/L00653 ?146, RMBOD 00053 01616, RMBOD 00053 1161, RMBAD 00054 1161, RMBAD 00054 1161, RMBAD 00054 1161, RMBAD, RG, TREATED WASTEWATER FLOW RATE', F9.5, 'MGD EXCEED TO0054 1162 00054 1050 00054 1050 00054 1050 00054 1050 00054 1050 00054 1050 00054 1050 00054 1052 00054 1063 00055 1163 00055 1163 00055 1163 00055 1163 00055
***) PRIN** *HE MI SHOW FORM. *HE MI SFORM. *ER AI GO T FORM. *HE DI FORM. *HE CALL PRIN* 63 FORM. */L GO T 55 FORM. */L 56 FORM. */L 57 FORM. */L 56 FORM. */L 57 FORM. */L 57 FORM. */L 58 FORM. 58 FORM. 5	'146,RMBOD 00053 .T16,RMBOD 00053 .T11 THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO 00053 NICIPAL TREATMENT PLANT: ',F5.1,' MG/L') 00053 RESTRICTION ITEMS 00053 01T.LE.DQIT) 00051 0155,PQIT.DQIT 00053 01T.LE.DQIT) 00053 01T.LE.DQIT) 00054 0155,PQIT.DQIT 00054 0155,PQIT.DQIT 00054 0151,SIGN CAPACITY',F9.5,'MGD') 00054 0151,CENCITY',F9.5,'MGD') 00054 0151,CENCITY',F9.5,'MGD') 00054 011,LE.RMBOD, DGO TO 164 00054 102 00054 102 00054 102 00054 112,LE.RMBOD, DGO TO 164 00055 112,LE.RMBOD, DGO TO 164 00055 114(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION LIMITS', F5.1, 'MG/L0055 1163 00055 1164 00055 1165 SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDENO055 1161 00055 1162 00055 1163 00055 <td< td=""></td<>
16 FORM *HE MI FF (1) FF FORM *HE DI 55 FORM *HE DI 56 FORM *ER AI 56 FORM */L L */L CALL IF (1) 63 FORM 164 CALL IF (1) 63 FORM 55 FORM	T(' THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO TODO53 NICIPAL TREATMENT PLANT :',F5.1,' MG/L') 00053 RESERICTION ITEMS QIT.LE.DQIT) GO TO 161 155,PQIT.DQIT 155,PQIT.DQIT 155,PQIT.DQIT 00053 SIGN CAPACITY',F9.5,'MGD') 00054 1510 CAPACITY',F9.5,'MGD') 00054 1510 CAPACITY',F9.5,'MGD') 00054 1510 CAPACITY',F9.5,'MGD') 00054 100 100017.LE.RMBOD) GO TO 164 00054 100017.LE.RMBOD DOT 164 00054 102 00055 163 00055 163 00055 163 00055 163 00055 163 00055 164 00055 163 00055 164 00055 163 00055 1042 00055 102 </td
SHOW IF (1) PRIN' 55 FORM. *HE DI PRIN' 66 FORM. *ER AI 61 IF (1) 62 FORM. */L LI */) 63 FORM. *ALT' 64 CALL IF (1) 64 CALL IF (1) 75 PRIN' 85 FORM.	RESTRICTION ITEMS 00653 01T.LE.DOIT) GO TO 161 00653 155.PQIT.DQIT 00054 155.PQIT.DQIT 00054 155.PQIT.DQIT 00054 155.PQIT.DQIT 00054 155.PQIT.DQIT 00054 156.PQIT.DQIT 00054 151.COLL 00054 151.COLL 0054 151.COLL 0054 151.COLL 0054 162.COLL 0054 102.COLL 0055 103.COLL 0055 163.COLL 00055 164.COLL 00055 163.COLL 00055 164.COLL 00055 1052.COLL 00055 1052.COLL 00055 1052.COLL 00055 1052.COLL 00055 1052.C
IF (1) PRIN* *PRIN* 55 FORM. *BE DI *PRIN* 56 FORM. *ER AI GD TT *FRIN* 51 IF (1) *FRIN* 52 FORM. * ALTI GD TT 54 GOT 54 FORM. * ALTI GD TT 54 GOT 54 FORM. * ALTI GET 75 PRIN* 55 FORM.	YOIT.LE.DQIT) GO TO 161 00653 Y155.P0IT.DQIT 00054 Y155.P0IT.DQIT 00054 Y155.P0IT.DQIT 00054 Y156.P0IT.DQIT 00054 Y156.P0IT.DQIT 00054 Y156.P0IT.P0IT 00054 Y156 SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIDUOS4 Y171 00054 Y171 00055 Y163 00055 Y163 00055 Y163 00055 Y163 00055 Y163 00055 Y164 00055 Y163 00055 Y164 00055 Y17 00055
PRIN' 55 FORM *NE DI FORM. *ER AI GO T 51 IF (1) PRIN' 52 FORM. */L LL *') PRIN' 53 FORM. * ALT' GO T 54 CALL IF (1) PRIN' 53 FORM. * ALT' 55 FORM. 55 FORM. 56 FORM. 57 FORM. 58 FORM. 58 FORM. 58 FORM. 59 FORM. 50 FORM. 51 FORM. 52 FORM. 53 FORM. 54 FORM. 55 FORM. 56 FORM. 57 FORM. 57 FORM. 58 FORM	^155.poif.poif 0064 r(' HARNING: THEATED WASTEWATER FLOW RATE',F9.5,'MGD EXCEED 00054 00054 r16 00054 r16 00054 r16 00054 r17' SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIDUODS4 r16' SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIDUODS4 r16' NOD54 r162, RMBOD, DBODIT 00054 r162, RMBOD, DBODIT 00054 r162, RMBOD, DBODIT 00054 r162, RMBOD, DBODIT 00055 r163 00055 r164
*HE DI PRIN' 56 FORM. 61 IF (1) 762 FORM. */L L(*') 9711. 63 FORM. 63 FORM. 64 CALL IF (Q2IT. 65 FORM. 65 FORM. 65 FORM.	SIGN CAPACITY', F9.5, 'MGD') 0054 '156 0054 TERNATIVE 3,4,5,6') 0054 DODIT.LE, RMBODJ GO TO 164 0054 DADDIT.LE, RMBODJ GO TO 164 0054 VI(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/0054 VERNATIVE 3,6') 00054 DADDIT.LE, RMBODJ GO TO 164 0055 VI(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION LIMITS', F5.1, 'MG/L00055 163 STRNATIVE 3,6') 00055 D162 00055 VESNO(IA) 00055 VESU (IA) 00055 VALOR 00055 VESU (IA) 00055 VEQL2 00055 VEQL2 00055
PRIN' 56 FORM 51 FCRM 61 FF (1 PRIN' 62 FORM */L L(*') 63 FORM 63 FORM 64 CALL 02 IT 64 CALL 02 IT 75 PRIN' 85 FORM	156 00054 tr(' SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIDUODS4 JD2 00054 DBODIT.LE.RMBOD) GO TO 164 00054 T(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG0054 00054 VI(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG10055 00055 r163 00055 r161 SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER0055 RNATIVE 3,6') 00055 102 00055 SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER0055 00055 SORATIVE 3,6') 00055 102 00055 102 00055 102 00055 102 00055 102 00055 102 00055 102 00055 A, EQ.2) GO TO 102 00055
56 FORMA GO TC GO TC 61 IF (I) 62 FORMA */L LC */) PRIN' 63 FORMA GO TC 64 CALL IF (C) Q2IT' 75 PRIN' 85 FORMA	VT(' SORRY THIS IS INFEASIBLE SOLUTION, PLEASE CONSIDUOD54 DODS 00054 DADIT.LE.RMBODJ GO TO 164 00054 DADOIT.LE.RMBODJ GO TO 164 00054 VIC:RMBOD.DBODIT 00054 VIC:RMBOD.DBODIT 00054 VERS THE DESIGN BOD EFFLUENT CONCENTRATION 'F5.1', 'MG/D0054 VMERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITS', F5.1, 'MG/L00055 163 00055 SURATIVE 3,6') 00055 > 162 00055 YESNO(IA) 00055 0.02 00055 > 0012 00055 > 0022 00055 > 0023 00055 > 0024 00055 > 0025 00055 > 0025 00055 > 0025 00055 > 0025 00055 > 0025 00055 > 0012 00055 > 0025 00055 > 0025 00055 > 0025 00055 > 0015 00055 > 0015 00055
GO T GI IF (1) PRIN 62 FORMA */L L(*') PRIN 63 FORMA 64 CALL IF (1) Q217 GET 75 PRIN 85 FORMA) 102 0054 00054 00054 0054 162, RMBOD, DBODIT 0054 162, RMBOD, DBODIT 00054 162, RMBOD, DBODIT 00055 163 00055 163 00055 163 00055 163 00055 164 00055 162 00055 162 00055 162 00055 162 00055 163 00055 164 00055 165 00055 165 00055 166 00055 166 00055 167 00055 167 00055 168 00055 169 00055 16
61 IF (1 PRIN" 62 FORMA */L L(*') PRIN" 63 FORMA * ALTI GO TC 64 CALL IF (1 Q2IT' Q2IT' 75 PRIN" 85 FORMA	JBODIT,LE,RHBOD) GO TO 164 00054 T 162,RHBOD,DBODIT 00054 VI(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1,'MG/00054 00055 VERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITS', F5.1,'MG/00054 00055 163 00055 VI(' SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER00555 00055 202 00055 203 00055 204 00055 205 00055 202 00055 203 00055 204 00055 205 00055 202 00055 203 00055 204 00055 205 00055 205 00055 205 00055 205 00055 205 00055 205 00055 205 00055 205 00055 205 00055 205 00055
PRIN 62 FORMA */L L(*') PRIN 63 FORMA 64 CALL IF (Q21T GET 75 PRIN 85 FORMA	<pre>r 162.RMBOD_DBODIT 00054 tr('wARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1,'MG/D0054 WERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITS', F5.1,'MG/L00055 r 163 00055 r 163 SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER000355 (RNATIVE 3,6') 00055) 102 00055 y 25ENO(1A) 00055 (A.EQ.2) GO TO 102 00055 (A.EQ.2) GO TO 102 00055</pre>
*/L L(*') PRIN 63 FORM 63 FORM 64 CALL IF () 64 CALL IF () 64 CALL 75 PRIN 85 FORM	WRERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITS',F5.1,'MG/L00055 163 00055 1f(1 SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER00055 SRNATIVE 3,6') 00055 YESNO(IA) 00055 ALEQ.2) GO TO 102 PQIT 00055
*') PRIN 63 FORM 63 FORM 64 CALL 64 CALL IF () 021T GET 75 PRIN 85 FORM	00055 00055 xT(' SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER00055 xRNATIVE 3,6') 00055 > 102 00055 YESNO(IA) 00055 A.EQ.2) GO TO 102 PQIT 00055
63 FORM * ALT GO TO 64 CALL IF (1 Q2IT GET 1 75 PRIN 85 FORM	"163 00055 T(' SORRY THIS INFEASIBLE SOLUTION, PLEASE CONSIDER00055 SRNATIVE 3,6') 00055 102 00055 VESNO(IA) 00055 A.EQ.2) GO TO 102 00055 PQIT 00055
* ALT GO TO 64 CALL IF () 021T GET) 75 PRIN 85 FORM	RNATIVE 3,6') 00655 0102 00655 YESNO(1Å) 00055 A.EQ.2) GO TO 102 PQIT 00055
GO TO 64 CALL IF (1 Q2IT GET 75 PRIN 85 FORM	102 00055 YESNO(IA) 00055 (A.EQ.2) GO TO 102 00055 PQIT 00055
64 CALL IF () GET 75 PRIN 85 FORM	YESNO(IA) 00055 A.EQ.2) GO TO 102 00055 PQIT 00055
Q2IT GET 75 PRIN 85 FORM	•PQIT 00055
GET 75 PRIN 85 FORM	YUII 00055
75 PRIN 85 FORM	
85 FORM READ	185 00056
	T(1X,'ENTER DESIRED BCD EFFLUENT CONCENTRATION (MG/L)') 00056
01 PRIN	r 100 00056
00 FORM	T(1X, 'THIS IS YOUR ALTERNATIVE') 00056
	<pre>NT(1X,'PRETREATED WASTEWATER FLOW RATE :',F7.3,'MGD') 00056 205,B0D21T 00056</pre>
05 FORM	MT(1X,'EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') 00056
	CORRECTION 00056
	T(' IS THIS CORRECT') 00057
03 PRIN	C 225 00057
	NT('ENTER 1 IF CORRECT') 00057
35 FORM	235 . VT('ENTER 2 IF WANT TO CHANGE BOD EFFLUENT CONCENTRATION') 00057 245
45 FORM	T(' ENTER 3 IF WANT TO SELECT DIFFERENT ALTERNATIVE') 00057
READ GO TO	,IC 00057) (265,175,102),IC 00057
PRIN	r 255,IC 00058
* REAS	VT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A00058 SONABLE VALUE') 00058
GO T(65 IF (1	0 103 00058 0021T.LE.RMBOD) GO TO 285 00058
75 FORM	275,BOD21T,RMBOD . 0005E

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	* PUT & REASONABLE VALUE OR ENTER -1 TO SELECT DIFFERENT ALTERNAT	00058800
	*VE')	00058900
	READ*, FLG	00059000
	IF (FLG.GE.O.) GO TO 305	00059100
102	IFLAG=1	00059200
	BOD2IT=0.	00059300
	GO TO 335	00059400
305	BODZIT=FLG	00059500
	GO TO 101	00059600
285		00059700
	PRINT 325, BOD2IT, DBODIT	00059800
325		L00059900
	*OWERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITATION', F5.1, 'MG/	
	**)	00060100
326	PRINT 326	00060200
326	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO SELECT E *FFERENT ALTERNATIVE')	00060400
	READ*, FLG	00060500
	IF (FLG.GE.0.) GO TO 305	00060600
	GO TO 102	00060700
335		00060800
	END	00060900
		00061000
С	THIS SUBROUTINE IS USED FOR ALTERNATIVE "SEND ALL WASTE TO THE	00061100
с	MUNICIPAL TREATMENT WITHOUT TREATMENT"	00061200
	SUBROUTINE SEMP(IFLAG, PQIT, PBODIT, Q3IT, BOD3IT, TDPIT, RMBOD)	00061300
	IFLAG=0	00061400
	PRINT 105	00061500
105		
	*,')	00061700
	BOD3IT=PBODIT IF (TDPIT.LE.0.) GO TO 103	00061800 00061900
	PRINT 115, TDPIT	00062000
115	FORMAT(' NUMBER OF PERMITS BOUGHT IS', F5.0, 'SORRY THIS IS INFEASI	800062300
	*LE SOLUTION, PLEASE CONSIDER ALTERNATIVE 1,4')	00062200
	GO TO 102	00062300
103	IF (BOD3IT.LE.RMBOD) GO TO 104	00062400
	PRINT 125, BOD3IT, RMBOD	00062500
125	FORMAT(' WARNING: TREATED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/L	
	*OWERS THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/L')	00062700
	PRINT 135	00062800
135		
	* ALTERNATIVE 1,2,6') GO TO 102	00063000
104	CALL YESNO(IA)	00063100 00063200
104	IF (IA.EQ.2) GO TO 102	00063300
	Q3IT=PQIT	00063400
	PRINT 100	00063500
100	FORMAT(1X, 'THIS IS YOUR ALTERNATIVE')	00063600
	PRINT 145.031T	00063700
145		00063800
	* :',F6.2,'MGD')	00063900
	PRINT 155, BOD31T	00064000
155		
~	*LANT :',F6.2,'MG/L') MAKE CORRECTION	00064200
с	PRINT 165	00064300 00064400
165		00064500
101	PRINT 175	00064600
175	FORMAT(' ENTER 1 IF CORRECT')	00064700
	PRINT 185	00064800
185	FORMAT(' ENTER 2 IF WANT TO SELECT DIFFERENT ALTERNATIVE')	00064900
-	READ*,IC	00065000
	GO TO (205,102),IC	00065100
	PRINT 195,1C	00065200
195	FORMAT(' WARNING: 12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT	A00065300

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	* REASONABLE VALUE')	00065400
	GO TO 101	00065500
102	IFLAG=1	00065600
	Q3IT=0.	00065700
	BOD31T=0.	00065800
205	RETURN	00065900
	END	00066000
		00066100
	THIS SUBROUTINE IS USED FOR ALTERNATIVE "TREAT PART IN THE COMPANY	200066200
	PLANT & RELEASE, SEND THE OTHER PART WITHOUT TREATMENT TO THE	00066300
	MUNICIPAL PLANT"	00066400
	SUBROUTINE TPCWM(IFLAG, DQIT, DBODIT, PQIT, PBODIT, SQIT, SBODIT, QIIT, BO	000066500
	*DIIT,Q3IT,BOD3IT,TDPIT)	00066600
	IFLAG=0	00066700
	SHOW BASIC INFORMATION	00066800
	PRINT_105	00066900
105	FORMAT (' TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE OTHER	
	 PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT') 	00067100
	PRINT 115, DQIT	00067200
:15	FORMAT(' CURRENT DESIGN CAPACITY :',F7.3,'MGD')	
	PRINT 125, DBODIT	00067400
125	FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :',F5.1,' MG/I	00067500
	**)	00067600
	IF (TDPIT) 126,127,128	00067700
126	PRINT 129, ABS(TDPIT)	00067800
129	FORMAT(' NUMBER OF PERMITS SOLD :', F6.2)	00067900
20	GO TO 127 PRINT 130, TDPIT	00068000
-28 130		00068100
227	FORMAT(' NUMBER OF PERMITS BOUGHT :',F6.2) PRINT 135.POIT	00068200 00068300
-35	FORMAT(' EXPECTED WASTEWATER FLOW RATE :',F7.3,'MGD')	
- 30	PRINT 145, PBODIT	00068500
145		100068600
- 10		00068700
	PRINT 154, SQIT	00068800
154	FORMAT(' THE MAXIMUM LIMITATION OF WASTEWATER FLOW RATE TO THE RIV	
	*ER :',F7.3,'MGD')	00069000
	PRINT 155, SBODIT	00069100
:55	FORMAT(' THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO T	00069200
	*HE RIVER :', F7.3, 'MG/L')	00069300
	SHOW RESTRICTION ITEMS	00069400
101	CALL YESNO(IA)	00069500
	IF (IA.EQ.2) GO TO 102	00069600
	GET INPUT DATA	00069700
106	IN=0	00069800
385	PRINT 185	00069900
185	FORMAT(1X, 'ENTER TREATED WASTEWATER FLOW RATE IN THE COMPANY PLANT	
	* (MGD)')	00070100
	READ*,QIIT	00070200
104	IF (QIIT.LE.PQIT) GO TO 201	00070300
. OF	PRINT 195,011T, POIT	00070400
195	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE IN THE COMPANY PLAN	
	<pre>*T',F7.3,'MGD EXCEEDS THE PRODUCTION WASTEWATER FLOW RATE',F7.3,'MC *D')</pre>	
	PRINT 196	00070700
196	FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION PLEASE INPUT	
- 20	*A REASONABLE VALUE')	00071000
	GO TO 385	00071100
201	IF (QIIT.LE.DQIT) GO TO 205	00071200
-01	PRINT 197,Q11T,DQ1T	00071300
:97	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE IN THE COMPANY PLAN	
	"T', F7.3, 'MGD EXCEEDS THE DESIGN CAPACITY', F7.3, 'MGD')	00071500
	PRINT 198	00071600
198	FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION PLEASE INPUT A	

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198 FORMAR(" SORRY THIS IS INFEASIBLE SOLUTION PLEASE INPUT A00671700 * REASONABLE VALUE OR ENTER -1 TO SELLECT DIFFERENT ALTERNATIVE") 00071800 READ",FLG 00071900

IF (FLG.GE.0.) GO TO 325 000	72000
	72100
	72200
	72300
	372400
	72500
)72600)7270D
	72800
C199 FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE IN THE COMPANY PLANDOD	
C *T', F7.3, 'MGD EXCEEDS THE MAXIMUM LIMITATION OF WASTEWATER FLOW RATEOOD	73000
	073100
	73200
)73300)73400
	73500
	73600
	73700
	73800
<pre>175 FORMAT(1X,'ENTER DESIRED BOD EFFLUENT CONCENTRATION FROM THE COMPA000 *NY PLANT & RELEASE TO THE RIVER (MG/L)') 000</pre>	
	074000 074100
	74200
	74300
	074400
	74500
	74600
)74700)74800
	74900
235 FORMAT(1X,'2.TREATED WASTEWATERE BOD EFFLUENT CONCENTRATION :', F5.000	75000
	075100
PRINT 245,Q3IT 000 245 FORMAT(1X.'WITHOUT TREATMENT WASTEWATER FLOW RATE :'.F7.3.'MGD') 000	075200
)7530C)7540C
255 FORMAT(1%, WITHOUT TREATMENT WASTEWATER BOD EFFLUENT CONCENTRATIONOOC	75500
<pre>255 FORMAT(1X, WITHOUT TREATMENT WASTEWATER BOD EFFLUENT CONCENTRATIONOOC * :',F5.1,'MG/L') 000</pre>	75600
C IF (DTBOD) 110,111,112 000	75700
C 110 PRINT 256, ABS(DTBOD) 000	75800
C 256 FORMAT(1X, 'THE ALLOWED BOD EFFLUENT CONCENTRATION WILL BE DECREASEOOD C D BY',F6.1, 'MG/L BY SELLING PERMITS') 000	075900 076000
	76100
	76200
C 257 FORMAT(1X, 'THE ALLOWED BOD EFFLUENT CONCENTRATION WILL BE INCREASE000	76300
C D BY', F6.1, 'MG/L BY BUYING PERMITS') 200	7640D
C 113 PRINT 258, SBODIT C 258 FORMAT(1X, THE CURRENT MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRONO	76500
)76500)76700
	76800
	76900
	77000
	77100
	77200
)77300)77400
	77500
295 FORMAT(' ENTER 3 IF WANT TO INPUT DATA AGAIN') 000	77600
	77700
305 FORMAT(' ENTER 4 IF WANT TO SELECT DIFFERENT ALTERNATIVE') 000	77800
	77900
	78000 78100
315 FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A000	78200
* REASONABLE VALUE') 000	78300
	78400
345 PRINT 355 000	78500

129

55	FORMAT(' TYPE VARIABLE NUMBER TO BE CHANGED') 00078600
	PRINT 365 00078700
:65	FORMAT(' FOR EXAMPLE: TYPE 2 FOR TREATED BOD EFFLUENT CONCENTRATIO00078800
	*N TO THE RIVER') 00078900
	READ*,IN 00079000
	GO TO (385,109),IN 00079100
	PRINT 375,IN 00079200
75	FORMAT(' WARNING:', I2,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A00079300
	* REASONABLE VALUE') 00079400
	GO TO 345 00079500
-09	PRINT 175 00079600
	READ*, BODIIT 00079700
108 195	PRINT 395 00079800 FORMAT(' ENTER 1 IF CORRECT') 00079900
190	
;05	PRINT 405 00080000 FORMAT(' ENTER 2 IF NEED TO MAKE MORE CORRECTION') 00080100
105	READ*, IB 00080200
	1F (1B.EQ.1) GO TO 107 00080300
	IF (IB.EQ.2) GO TO 345 00080400
	PRINT 415,18 00080500
-15	FORMAT(' WARNING:', 12.' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A00080600
	* REASONABLE VALUE') 00080700
325	IF (BODIIT.LE.SBODIT) GO TO ;55 00080800
	PRINT 425, BODIIT, SBODIT 00080900
;25	FORMAT(' WARNING: TREATED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/L L000B1000
	*OWERS THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/L') 00081100
	PRINT 426 00081200
.26	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO CO081300
	SELECT DIFFERENT ALTERNATIVE') 00081400 READ.FLG 00081500
	IF (FLG.GE.0.) GO TO 435 00081600 GO TO 102 00081700
;35	BODIIT=FLG 000B1800
155	GO TO 107 00081900
455	IF (BODIIT.GE.DBODIT) GO TO :75 00082000
	PRINT 465, BODIIT, DBODIT 00082100
÷65	FORMAT(' WARNING: TREATED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/L L000B2200
	*OWERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITATION', F5.1, 'MG/L00082300
	•') 00082400
	PRINT 466 00082500
÷66	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO SELECT DI00082600 *FFERENT ALTERNATIVE') 00082700
	FFERENT ALTERNATIVE') 00082700 READ,FLG 00082800
	IF (FLG.GE.0.) GO TO 305 00082800
	GO TO 108 00083000
;75	RETURN 00063100
	END 00063200
	. 00083300
	THIS SUBROUTINE IS USED FOR SUBROUTINE "PRETREAT PART IN THE 00083400
	COMPANY PLANT & SEND TO THE MUNICIPAL PLANT, SEND THE OTHER PART 00083500
	WITHOUT TREATMENT TO THE MUNUCIPAL PLANT" 000B3600
	SUBROUTINE PPCWM(IFLAG, DQIT, DBODIT, PQIT, PBODIT, RMBOD, Q2IT, BOD2IT, Q00083700
	*3IT, BOD3IT, TDPIT) 00083800
	IFLAG=0 00083900
	SHOW BASIC INFORMATION · 00064000
· 05	PRINT 105 00084100
105	FORMAT(' PRETREAT PART IN THE COMPANY PLANT & SEND TO THE MUNICIPA00084200
	*L PLANT, SEND THE OTHER PART WITHOUT TREATMENT TO THE MUNICIPAL PL00084300 *ANT') 00084400
	IF (TDPIT.LE.O.) GO TO 110 00084500
	PRINT 114,TDPIT 00084600
114	FORMAT(' NUMBER OF PERMITS BOUGHT IS', F5.0, 'SORRY THIS IS INFEASIBOOD84700
	*LE SOLUTION, PLEASE CONSIDER ALTERNATIVE 1.4') 00084800
	GO TO 102 00084900
110	PRINT 115, DQIT 00085000
115	FORMAT(' CURRENT DESIGN CAPACITY :',F7.3,'MGD') 00085100

	PRINT 125, DBODIT 00085200
125	FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :'.F5.1.' MG/L00085300
	*') 00085400 PRINT 135.POIT 00085500
135	FORMAT(' EXPECTED WASTEWATER FLOW RATE :',F7.3,'MGD') 00085500
100	PRINT 145, PBODIT 00085700
145	FORMAT(' EXPECTED BOD INFLUENT CONCENTRATION :', F5.1,' MG/L00085800
	*') 00085900 PRINT 146.RMBOD 00086000
146	PRINT 146,RMBOD 00086000 FORMAT(' THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO T00086100
	*HE MUNICIPAL TREATMENT PLANT :',F5.1,'MG/L') 00086200
С	SHOW RESTRICTION ITEMS 00086300
	IF (DBODIT.LE.RMBOD) GO TO 101 00086400 PRINT 147.RMBOD.DBODIT 00086500
147	FORMAT(' WARNING: THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG00086600
	*/L LOWERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITATION', F5.1, '00086700
	*MG/L') 00086800
148	PRINT 148 00086900 FORMAT(' SORRY THIS 15 INFEASIBLE SOLUTION, PLEASE CONSID00087000
+	*ER ALTERNATIVE 3,6') 00087100
	GO TO 102 00087200
101	CALL YESNO(IA) 00087300 IF (IA.EQ.2) GO TO 102 00087400
с	GET INPUT DATA 00087500
106	IN=0 00087600
385 185	PRINT 185 00087700
100	FORMAT(1X, 'ENTER TREATED WASTEWATER FLOW RATE IN THE COMPANY PLANT00087800 * (MGD)') 00087900
	READ*,Q2IT 00088000
104	IF (Q2IT.LE.PQIT) GO TO 201 00088100
195	PRINT 195,Q2IT,PQIT 00088200 FORMAT(' WARNING: PRETREATED WASTEWATER FLOW RATE IN THE COMPANY P00086300
175	*LANT', F7.3, 'MGD EXCEEDS THE PRODUCTION WASTEWATER FLOW RATE', F7.3,00088400
	*'MGD') 00088500
196	PRINT 196 00088600 FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION PLEASE INPUT 00088700
150	*A REASONABLE VALUE') 00088800
	GO TO 385 00088900
201	IF (Q2IT.LE.DQIT) GO TO 205 00089000 PRINT 197,Q2IT.DQIT 00089100
197	FORMAT(' WARNING: PRETREATED WASTEWATER FLOW RATE IN THE COMPANY P00089200
	*LANT', F7.3, 'MGD EXCEEDS THE DESIGN CAPACITY', F7.3, 'MGD') 00069300
19B	PRINT 198 00089400 FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION PLEASE INPUT A00089500
	* REASONABLE VALUE OR ENTER -1 TO SELLECT DIFFERENT ALTERNATIVE') 00089600
	READ*, FLG 00089700
102	IF (FLG.GE.0.) GO TO 325 00089800 IFLAG=1 00089900
	Q21T=0. 00090000
	BOD21T=0. 00090100
325	GO TO 475 00090200 Q21T=FLG 00090300
020	GO TO 104 00090400
205	Q3IT=PQIT-Q2IT 00090500
	IF (IN.EQ.1) GO TO 108 00090600 PRINT 175 00090700
175	FORMAT(1X, 'ENTER DESIRED BOD EFFLUENT CONCENTRATION FROM THE COMPA00090800
	*NY PLANT & RELEASE TO THE RIVER (MG/L)') 00090900
	RÉAD*, BOD21T 00091000 BOD31T=PBODIT 00091100
107	PRINT 215 00091200
215	FORMAT(12, 'THIS IS YOUR ALTERNATIVE') 00091300
775	PRINT 225,021T 00091400 FORMAT(1X.'1.PRETREATED WASTEWATER FLOW RATE :'.F7.3.'MGD') 00091500
225	FORMAT(1X,'1.PRETREATED WASTEWATER FLOW RATE :',F7.3,'MGD') 00091500 PRINT 235,BOD2IT 00091600
235	FORMAT(1X, '2. PRETREATED WASTEWATER BOD EFFLUENT CONCENTRATION :', F00091700

	*5.1,'MG/L')	00091800
	PRINT 245,Q3IT	00091900
245	FORMAT(1X, WITHOUT TREATMENT WASTEWATER FLOW RATE : ', F7.3, 'MGD')	00092000
	PRINT 255, BOD3IT	00092100
255	FORMAT(1X, WITHOUT TREATMENT WASTEWATER BOD EFFLUENT CONCENTRATION	
	* :',F5.1,'MG/L')	00092300
	MAKE CORRECTION	00092400
	PRINT 265	00092500
265	FORMAT(' IS THIS CORRECT')	00092600
103	PRINT 275	00092700
275	FORMAT(' ENTER 1 IF CORRECT')	00092800
	PRINT 285	00092900
285	FORMAT('ENTER 2 IF NEED TO MAKE A CHANGE') PRINT 295 FORMAT('ENTER 3 IF WANT TO INPUT DATA AGAIN') PRINT 305 FORMAT('ENTER 4 IF WANT TO SELECT DIFFERENT ALTERNATIVE') READ*,IC GO TO (335,345,106,102),IC PRINT 315,IC FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT /	00093000
	PRINT 295	00093100
295	FORMAT(' ENTER 3 IF WANT TO INPUT DATA AGAIN')	00093200
	PRINT 305	00093300
305	FORMAT(' ENTER 4 IF WANT TO SELECT DIFFERENT ALTERNATIVE')	00093400
	READ*, IC	00093500
	GO TO (335,345,106,102),IC	00093600
	PRINT 315,IC	00093700
315	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A	00093800
	* REASONABLE VALUE')	00093900
	GO TO 103	00094000
345	PRINT 355	00094100
355	FORMAT(' TYPE VARIABLE NUMBER TO BE CHANGED')	00094200
	PRINT 365	00094300
365	FORMAT(' FOR EXAMPLE: TYPE 1 FOR PRETREATED WASTEWATER FLOW RATE'	
	READ*, IN	00094500
	GO TO (385,109),IN	00094600
	PRINT 375, IN	00094700
375	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT /	00094800
	* RESONABLE VALUE')	00094900
	GO TO 345	00095000
:09	PRINT 175	00095100
	READ*, BOD2IT	00095200
- 08	PRINT 395	00095300
395	FORMAT(' ENTER 1 IF CORRECT')	00095400
	PRINT 405	00095500
-05	FORMAT(' ENTER 2 IF NEED TO MAKE MORE CORRECTION')	00095600
	READ*, IB	00095700
	IF (IB.EQ.1) GO TO 107	00095800
	IF (IB.EQ.2) GO TO 345	00095900
	PRINT 415, IB	00096000
415	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT /	
	* REASONABLE VALUE')	00096200
	GO TO 108	00096300
335	IF (BOD2IT.LE.RMBOD) GO TC 455	00096400
	PRINT 425, BODZIT, RMBOD	00096500
-25	FORMAT(' WARNING: PRETREATED BOD EFFLUENT CONCENTRATION', F5.1, 'MG,	00096600
	*L LOWERS THE ALLOWED BOD EFFLUENT CONCENTRATION', F5.1, 'MG/L')	
	PRINT 426	00096800
-26	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO S	
	*ELECT DIFFERENT ALTERNATIVE')	00097000
	READ*, FLG	00097100
	IF (FLG.GE.0.) GO TO 435	00097200
	GO TO 102	00097300
:35	BOD2IT=FLG	00097400
	GO TO 107	00097500
455	IF (BOD2IT.GE.DBODIT) GO TO 475	00097600
	PRINT 465, BOD2IT, DBODIT	00097700
465	FORMAT(' WARNING: PRETREATED BOD EFFLUENT CONCENTRATION', F5.1, 'MG,	00097800
	*L LOWERS THE DESIGN BOD EFFLUENT CONCENTRATION LIMITS', F5.1, 'MG/L'	
	*)	00098000
	PRINT 466	Ú0098100
÷66	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TOS	
	*ELECT DIFFERENT ALTERNATIVE')	00098300

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	READ*, FLG	00098400
	IF (FLG.GE.0.) GO TO 435	00098500
	GO TO 102	00098600
475	RETURN	00098700
	END	00098800
		00098900
с	THIS SUBROUTINE IS USED FOR SUBROUTINE "DISCHARGE WITHOUT PERMIT"	
-	SUBROUTINE WDUMP(IFLAG, PQIT, PBODIT, Q4IT, BOD4IT, TDPIT)	00099100
	IFLAG=0	00099200
с	SHOW BASIC INFORMATION	00099300
•	PRINT 105	00099400
105	FORMAT(1X, 'DISCHARGE WITHOUT PERMIT')	00099500
105	IF (TDPIT.LE.O.) GO TO 103	00099600
	PRINT 115, TDPIT	00099700
115	FORMAT(' NUMBER OF PERMITS BOUGHT IS', F5.0, 'SORRY THIS IS INFEASI	
	*LE SOLUTION, PLEASE CONSIDER ALTERNATIVE 1, 4, 7 OR 8')	00099900
	GO TO 102	00100000
103		00100100
100	IF (IA.EQ.2) GO TO 102	00100200
	04IT=POIT	00100300
	BOD4IT=PBODIT	00100400
	PRINT 100	00100500
100	FORMAT(1X, 'THIS IS YOUR ALTERNATIVE')	00100600
100	PRINT 145,Q4IT	00100700
145	FORMAT(1X, 'DISCHARGE WASTEWATER FLOW RATE :',F7,3, 'MGD')	00100800
	PRINT 155, BOD4IT	00100900
155		00101000
с	MAKE CORRECTION	00101100
	PRINT 165	00101200
165	FORMAT(' IS THIS CORRECT')	00101300
101	PRINT 175	00101400
175	FORMAT(' ENTER 1 IF CORRECT')	00101500
	PRINT 185	00101600
185	FORMAT(' ENTER 2 IF WANT TO SELECT DIFFERENT ALTERNATIVE')	00101700
	READ*,IC	00101800
	GO TO (205,102),IC	00101900
	PRINT 195.IC	00102000
195	FORMAT(' WARNING:', 12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT	A00102100
	* REASONABLE VALUE')	00102200
	GO TO 101	00102300
102	IFLAG=1	00102400
	Q4IT=0.	00102500
	BOD4IT=0.	00102600
205	RETURN	00102700
	END	00102800
		00102900
с	THIS SUBROUTINE IS USED FOR ALTERNATIVE "TREAT PART IN THE COMPAN"	
с	PLANT & RELEASE, SEND THE OTHER PART WITHOUT TREATMENT TO THE	00103100
с	RIVER"	00103200
	SUBROUTINE TPSR (IFLAG, DQIT, DBODIT, PQIT, PBODIT, SQIT, SBODIT, QIIT, B	
	*DIIT,Q4IT,BOD4IT,TDPIT)	00103400
	IFLAG=0	00103500
с	SHOW BASIC INFORMATION	00103600
	PRINT 105	00103700
105	FORMAT(' TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE OTHE	
	* PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT')	00103900
175	PRINT 115, DQIT	0010+000
115		
125	PRINT 125, DBODIT	00104200
125	FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :',F5.1,' MG/. *')	LC0104300
		00104400
126	IF (TDPIT) 126,127,128	00104500 00104600
129	PRINT 129, ABS(TDPIT) FORMAT(' NUMBER OF PERMITS SOLD :',F6.2)	C0105700
229	GO TO 127	00104800
128	PRINT 130, TDPIT	00104900
		22204200

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30	FORMAT(' NUMBER OF PERMITS BOUGHT	:',F6.2) 00105000
	PRINT 135, PQIT	00105100
35	FORMAT(' EXPECTED WASTEWATER FLOW RATE	:',F7.3,'MGD') 00105200
	PRINT 145, PBODIT	00105300
4	FORMAT(' EXPECTED BOD INFLUENT CONCENTRATION	:',F5.1,' MG/L00105400
	*')	00105500
	PRINT 154, SQIT	00105600
5.	FORMAT(' THE MAXIMUM LIMITATION OF WASTEWATER FLOW	
	*ER :',F7.3,'MGD')	00105800
	PRINT 155, SBODIT	00105900
51	FORMAT(' THE MAXIMUM LIMITATION OF BOD EFFLUENT CO	
	*HE RIVER :',F7.3,'MG/L')	00106100
	SHOW RESTRICTION ITEMS	00106200
. 0.	CALL YESNO(1A)	00106300
	IF (IA.EQ.2) GO TO 102	00106400
0	GET INPUT DATA	00106500
	IN=0	00106600
	PRINT 185	00106700
	FORMAT(1X, 'ENTER TREATED WASTEWATER FLOW RATE IN T * (MGD)')	
	READ*,Q11T	00106900
3	IF (QIIT.LE.POIT) GO TO 201	00107000 00107100
0.	PRINT 195,QLIT,PQIT	00107200
9	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE IN '	
2.	*T', F7.3, 'MGD EXCEEDS THE PRODUCTION WASTEWATER FLO	W PATE' E7 3 'MC00107300
	*p')	00107500
	PRINT 196	00107600
9(FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION	
	*A REASONABLE VALUE')	00107800
	GO TO 385	00107900
:0:	IF (QIIT.LE.DQIT) GO TO 205	00108000
	PRINT 197, QLIT, DQIT	00108100
. 9'	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE IN '	THE COMPANY PLAN00108200
	*T',F7.3, MGD EXCEEDS THE DESIGN CAPACITY',F7.3, MG	D') 00108300
	PRINT 198	00108400
91	FORMAT(' SORRY THIS IS INFEASIBLE SOLUTION	N PLEASE INPUT A00108500
	* REASONABLE VALUE OR ENTER -1 TO SELLECT DIFFERENT	
	READ*, FLG	00108700
	IF (FLG.GE.O.) GO TO 325	00108800
.0.	IFLAG=1	00108900
	QIIT-0.	00109000
	BODIIT=0.	00109100
10	GO TO 475 Olit=FLG	00109200 00109300
,	GO TO 104	00109300
.0.	IF (QIIT.LE.SQIT) GO TO 205	00109400
0.	PRINT 199,011T,SQIT	00109600
Q	FORMAT(' WARNING: TREATED WASTEWATER FLOW RATE IN '	
	*T', F7.3, MGD EXCEEDS THE MAXIMUM LIMITATION OF WAS	
	*E',F7.3,'MGD')	00109900
	PRINT 198	00110000
	READ*, FLG	00110100
	IF (FLG.GE.D.) GO TO 325	00110200
	GO TO 102	00110300
25	Q4IT=PQIT-Q1IT	00110400
	IF (IN.EQ.1) GO TO 108	00110500
	PRINT 175	00110600
. 71	FORMAT(1X, 'ENTER DESIRED BOD EFFLUENT CONCENTRATION	
	*NY PLANT & RELEASE TO THE RIVER (MG/L)')	00110800
	READ*, BODIIT	00110900
	MEASURE THE TOP'S EFFECT ON ALLOWED BOD EFFLUENT CO	
	BOD4IT=PBODIT	00111100
	PRINT 215	00111200
.11	FORMAT(1X, 'THIS IS YOUR ALTERNATIVE')	00111300
	PRINT 225,011T	00111400
-2	FORMAT(1X, '1. TREATED WASTEWATER FLOW RATE	",F7.3,'MGD') 00111500

76.2)	00105000		PRINT 235, BOD11T FORMAT(1X, '2.TREATED WASTEWATERE BOD EFFLUENT CONCENTRATION :',F *1,'MG/L') PRINT 245,041T FORMAT(1X,'DISCHARGED WASTEWATER FLOW RATE TO THE RIVER:',F7.3,') *GD') PRINT 255,BOD41T FORMAT(1X,'DISCHARGED WASTEWATER BOD EFFLUENT CONCENTRATION:',F5 *1,'MG/L') MAKE CORRECTION PRINT 265	06111600
7.3.'MGD')	00105100	235	FORMAT(12, '2.TREATED WASTEWATERE BOD EFFLUENT CONCENTRATION :', F	5.00111700
	00105300		PRINT 245,Q4IT	00111900
'5.1,' MG/	00105400	245	FORMAT(1X, DISCHARGED WASTEWATER FLOW RATE TO THE RIVER: ', F7.3, '	M 00112000
	00105600		PRINT 255, BOD41T	00112100
TO THE RIV	v00105700	255	FORMAT(1X, 'DISCHARGED WASTEWATER BOD EFFLUENT CONCENTRATION:', F5	. 00112300
	00105800	~	*1,'MG/L')	00112400
TRATION TO	000006000	Ľ	PRINT 265	00112600
	00100100	265	FORMAT(' IS THIS CORRECT')	00112700
	00106200 00106300	103	PRINT 275 Format(' Enter 1 IF Correct')	00112800 00112900
	00106400			00112000
	00106500	285	FORMAT(' ENTER 2 IF NEED TO MAKE & CHANGE')	00113100
	00106700	295	FORMAT(' ENTER 3 IF WANT TO INPUT DATA AGAIN')	00113200
MPANY PLAN	00106800		PRINT 305	00113400
	00107000	305	FORMAT(' ENTER 4 IF WANT TO SELECT DIFFERENT ALTERNATIVE')	00113500
	00107100		GO TO (475,345,106,102).IC	00113700
OMPANY DI M	00107200		PRINT 315,1C	00113800
CE', F7.3, 'M	500107400	315	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE')	A00113900
	00107500		GO TO 103	00114100
EASE INPUT	00107600	345	PRINT 355	00114200
	00107800	399	PRINT 365	00114300
	00107900	365	FORMAT(' FOR EXAMPLE: TYPE 2 FOR TREATED BOD EFFLUENT CONCENTRAT	1000114500
	00108100		*N TO THE RIVER')	00114600
OMPANY PLA	00108200		GO TO (385,109), IN	00114800
	00108300		PRINT 375, IN	00114900
ASE INPUT	400106500	375	PRINT 205 FORMAT(' ENTER 2 IF NEED TO MAKE & CHANGE') PRINT 295 FORMAT(' ENTER 3 IF WANT TO INPUT DATA AGAIN') PRINT 305 FORMAT(' ENTER 4 IF WANT TO SELECT DIFFERENT ALTERNATIVE') READ*,IC GO TO (475,345,106,102),IC PRINT 315,IC FORMAT(' WARNING:',I2,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 103 FORMAT(' TYPE VARIABLE NUMBER TO BE CHANGED') PRINT 355 FORMAT(' FOR EXAMPLE: TYPE 2 FOR TREATED BOD EFFLUENT CONCENTRAT * NT OT HE RIVER') READ*,IN GO TO (385,109),IN FORMAT(' WARNING:',I2,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 345 FORMAT(' WARNING:',I2,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 345 FORMAT(' ENTER 1 IF CORRECT') PRINT 395 FORMAT(' ENTER 1 IF CORRECT') PRINT 405 FORMAT(' ENTER 2 IF NEED TO MAKE MORE CORRECTION')	00115000
ERNATIVE')	00108600		GO TO 345	00115200
	00108700	109	PRINT 175 READ*, BODIT FRINT 395 FORMAT(' ENTER 1 IF CORRECT') FORMAT(' ENTER 2 IF NEED TO MAKE MORE CORRECTION') READ*, IB IF (IB.EQ.1) GO TO 107 IF (IB.EQ.2) GO TO 107 IF (IB.EQ.2) GO TO 345 PRINT 415, IB FORMAT(' WARNING:', 12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 108 RETURN END THIS SUBROUTINE IS USED FOR SUBROUTINE "DISCHARGE WITH PERMIT" SUBROUTINE WEDDUNG(IFLAG, FQIT, PEODIT, Q4IT, BOD4IT, TDFIT)	00115300
	00108900	108	PRINT 395	00115500
	00109000	395	FORMAT(' ENTER 1 IF CORRECT')	00115600
	00109200	405	PRINT 405 FORMET(' ENTER 2 IF NEED TO MAKE MORE CORRECTION')	00115700
	00109300		READ*, IB	00115900
	00109400		IF (IB.EQ.1) GO TO 107	00116000
	00109600		PRINT 415.1B	00116100
COMPANY PLAN	100109700	415	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT	A00116300
ER FLOW RA	00109900		* REASONABLE VALUE')	00116400
	00110000	475	RETURN	00116600
	00110100		END	00116700
	00110300	с	THIS SUBROUTINE IS USED FOR SUBROUTINE "DISCHARGE WITH DERMIT"	00116800
	00110400	-	SUBROUTINE WPDUMP(IFLAG, PQIT, PEODIT, Q4IT, BOD4IT, TDPIT)	00117000
	00110500 00110600	с	IFLAG=0 Show basic information	00117100 00117200
M THE COMPA	00110700			00117300
	00110800 00110900	105	FORMAT()X, 'DISCHARGE WITH PERMIT')	00117400
TRATION	00111000	111	IF (TDPIT,GT.0.) GO TO 114 PRINT 112, ABS(TDPIT) FORMAT(NUMBER OF PERMITS SOLD IS',F5.0,' SORRY THIS IS INFEASI	00117500
	00111100	112	FORMAT(' NUMBER OF PERMITS SOLD IS', F5.0, ' SORRY THIS IS INFEASI	BL00117700
	00111000 00111100 00111200 00111300		* SOLUTION, PLEASE CONDIDER OTHER ALTERNATIVE')	00117800
	00111400	114	PRINT 115.TDPIT	00117900 00118000
'.3,'MGD')	00111500	115	SOLUTION, PLEASE CONDIDER OTHER ALTERNATIVE') GO TO 102 PRINT 115,TDPIT FORMAT(' NUMBER OF PERMITS BOUGHT IS',F5.0)	00118100
		115	FURMAT(NUMBER OF PERMITS BOUGHT IS ,F5.0)	00118100
			·	

	CALL YESNO(IA)	0011820
	IF (IA.EQ.2) GO TO 102	0011830
	Q4IT=PQIT	0011840
	BOD4IT=PBODIT	0011850
~~	PRINT 100	0011860
00	FORMAT(1X,'THIS IS YOUR ALTERNATIVE') PRINT 145,Q4IT	001187
45	FORMAT(1X, 'DISCHARGED WASTEWATER FLOW RATE :', F7.3, 'MGD')	0011890
•••	PRINT 155, BOD4IT	0011900
55		0011910
	MAKE CORRECTION	0011920
	PRINT 165	001193
65 01	FORMAT(' IS THIS CORRECT') PRINT 175	0011940
75	FORMAT(' ENTER 1 IF CORRECT')	0011950
	PRINT 185	001197
85	FORMAT(' ENTER 2 IF WANT TO SELECT DIFFERENT ALTERNATIVE')	001198
	READ*, IC	0011990
	GO TO (205.102).IC	0012000
95	PRINT 195,IC	0012010
33	FORMAT(' WARNING:', I2,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE')	0012020
	GO TO 101	0012040
02	IFLAG=1	0012050
	Q4IT=0.	0012060
	BOD4IT=0.	0012070
05		0012080
	END	001209
	THIS SUBROUTINE IS USED FOR PRINTING ALTERNATIVE	0012110
	SUBROUTINE SALT(IS,QIIT,BOD1IT,Q2IT,BOD2IT,Q3IT,BOD3IT,Q4IT,BOD4I	
	*)	001213
	PRINT 201	001214
01	FORMAT(1X,'THIS IS YOUR ALTERNATIVE') GO TO (101,102,103,104,106,107,108,109),IS	001215
01	PRINT 105	0012160
05	FORMAT(' 1.TREAT EVERYTHING IN THE COMPANY PLANT & RELEASE.')	001218
	PRINT 115,Q1IT	0012190
15	FORMAT(' TREATED WASTEWATER FLOW RATE :', F7.3, ' MGD')	001220
	PRINT 125, BODIIT	0012210
	FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :', F5.1,' MG/L')	
25	CO TO 125	
	GO TO 325 PRINT 135	0012230
02	GO TO 325 PRINT 135 Format(' 2.Pretreat everything in the company plant 6 send to the	0012230
02	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.')	0012230 0012240 0012250 0012250
02 35	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T	0012230 0012240 0012250 0012260 0012270
02 35	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :'.F7.3.' MGD')	0012230 0012240 0012250 0012260 0012270 0012270
02 35 45	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,60021T	0012230 0012240 0012250 0012250 0012270 0012270 0012280 0012290
02 35 45	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :'.F7.3.' MGD')	0012230 0012240 0012250 0012260 0012270 0012280 0012290 0012290
02 35 45 55	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUDNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,B0D21T FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165	0012230 0012240 0012250 0012250 0012250 0012270 0012280 0012300 0012310 0012310
02 35 45 55 03	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.' PRINT 145.021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BODZIT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 FRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE	001223 001224 001225 001226 001227 001229 001230 001230 001231 001231 001232
02 35 45 55 03	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,60021T FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE *TMENT.')	0012230 001224 0012250 0012250 0012260 0012280 0012290 0012300 0012310 0012330 0012330
02 35 45 55 03 65	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.) PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BODZIT FORMAT(' SERVECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE *TMENT.') PRINT 175,031T	0012230 001224 0012250 0012250 0012260 0012270 0012280 0012300 0012310 0012330 0012340 0012340
02 35 45 55 03 65	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.' PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 FRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE *TMENT.') PRINT 175,031T FORMAT(1X,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD')	0012230 0012240 0012260 0012260 0012280 0012300 0012310 0012310 0012320 0012330 0012340 0012350 0012350
02 35 45 55 03 65 75	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE "MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BODZIT FORMAT(' 2.SEND BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE "THENT.') FORMAT(' 3.SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD3IT	0012230 0012240 0012250 0012250 0012270 0012290 0012300 0012310 0012330 0012330 00123340 00123340 0012350 0012350
02 35 45 55 03 65 75	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.' PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 FRINT 165.BOD ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE *TMENT.') PRINT 175,031T FORMAT(1X,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 165,BOD3IT FORMAT(1X,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L')	0012230 0012240 0012250 0012250 0012260 0012200 0012300 0012310 0012330 0012330 0012340 0012350 0012350 0012350 0012380
02 35 45 55 03 65 75 85 04	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE *TMENT.') PRINT 15.031T FORMAT(1X,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD3IT FORMAT(1X,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325	001223 001224 001224 001226 001226 001228 001229 001231 001231 001234 001234 001234 001234 001235 001238 001238 001238
02 35 45 55 03 65 75 85 04	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE "MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE "THENT.') FORMAT(' 3.SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 175,031T FORMAT(1X,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD3IT FORMAT(1X,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 195	0012230 0012240 0012260 0012260 0012260 0012270 0012290 0012310 0012310 0012310 0012310 0012310 0012350 0012350 0012350 0012350 0012350 0012350 0012350 0012350 0012350
02 35 45 55 03 65 75 85 04	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE *MUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE *TMENT.') PRINT 175,031T FORMAT(1X,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 185,BOD3IT FORMAT(1X,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325 FORMAT(1X, 'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325 FORMAT(' 4, TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE O *HER PARK WITHOUT TREATMENT TO THE MUNICIPAL PLANT.'	001223(001224) 001225(001225(001226) 001228(001229(001230) 001231(001234) 001234(001235(001237(001236) 001235(001237(001236) 001241(001241) 001241(001241)
02 35 45 55 03 65 75 85 04 95	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE HUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155, BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE "THENT.') FORMAT(12,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') FORMAT(12,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') FORMAT(12,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') FORMAT(12,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325 FORMAT(' 4. TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE O "HER PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT.') FRINT 305.01T	001223 001224 001225 001225 001226 001227 001228 0012231 001231 001231 001231 001231 001234 001234 001236 001236 001236 001237 001234 001237 001241 001242
02 35 45 55 03 65 75 85 04 95	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE HUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155,BODZIT FORMAT(' 2.SEND BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 165,BODZIT FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE "TMENT.') PRINT 175,031T FORMAT(' 3.SEND WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 175,BODZIT FORMAT(1X,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325 PRINT 195 FORMAT(' 4. TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE O "HER PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT.') PRINT 105,(3)1T FORMAT(12,,'TREAT PLANT FLOW RATE :',F7.3,'MGD')	00123 001224 001225 001225 001227 001227 001227 001232 001232 001231 001231 001231 001231 001234 001235 001235 001235 001239 001240 001240
	FORMAT(' 2.PRETREAT EVERYTHING IN THE COMPANY PLANT & SEND TO THE HUNICIPAL PLANT.') PRINT 145,021T FORMAT(' PRETREATED WASTEWATER FLOW RATE :',F7.3,' MGD') PRINT 155, BOD2IT FORMAT(' EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L') GO TO 325 FORMAT(' 3.SEND ALL WASTEWATER TO THE MUNICIPAL PLANT WITHOUT TRE "THENT.') FORMAT(12,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') FORMAT(12,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') FORMAT(12,'SEND WASTEWATER FLOW RATE :',F7.3,' MGD') FORMAT(12,'SEND WASTEWATER BOD CONCENTRATION :',F5.1,' MG/L') GO TO 325 FORMAT(' 4. TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE O "HER PART WITHOUT TREATMENT TO THE MUNICIPAL PLANT.') FRINT 305.01T	001226 001227 001228 001228 001231 001231 001231 001234 001234 001235 001236 001237 001236 001241 001241 001241 001243 001244 001243

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	PRINT 225,031T 00124800
225	FORMAT(1X, WITHOUT TREATMENT WASTEWATER FLOW RATE :', F7.3, 'MGD') 00124900
	PRINT 235, BOD3IT 00125000
235	FORMAT(1X, WITHOUT TREATMENT WASTEWATER BOD EFFLUENT CONCENTRATION00125100
	*:',F5.1,'MG/L') 00125200
	GO TO 325 00125300
106	PRINT 245 00125400
245	FORMAT(' 5. PRETREAT PART IN THE COMPANY PLANT & SEND TO MUNICIPAL00125500
	* PLANT, SEND THE OTHER PART WITHOUT TREATMENT TO THE MUNICIPAL PLA00125600
	*NT') 00125700 PRINT 255.021T 00125800
255	
200	
265	PRINT 265,BOD2IT 00126000 FORMAT(1X,'PRETREATED WASTEWATER BOD EFFLUENT CONCENTRATION :',F500126100
200	*.1.'MG/L') 00126200
	PRINT 275,Q3IT 00126300
275	FORMAT(1X, WITHOUT TREATMENT WASTEWATER FLOW RATE :', F7.3, 'MGD') 00126400
	PRINT 285, BOD31T 00126500
285	FORMAT(1X, WITHOUT TREATMENT WASTEWATER BOD EFFLUENT CONCENTRATION00126600
	* :',F5.1,'MG/L') 00126700
	GO TO 325 00126800
107	PRINT 295 00126900
295	FORMAT(' 6. DISCHARGE WITHOUT PERMIT') 00127000
	PRINT 305,Q41T 00127100 FORMAT(1X,'DISCHARGE WASTEWATER FLOW RATE :',F7.3,'MGD') 00127200
305	
315	PRINT 315,BOD41T 00127300 FORMAT(1X,'EXPECTED BOD EFFLUENT CONCENTRATION :',F5.1,' MG/L')00127400
315	GO TO 325 00127500
108	PRINT 335 00127600
335	FORMAT (' 7, TREAT PART IN THE COMPANY PLANT & RELEASE, SEND THE OT00127700
555	*HER PART WITHOUT TREATMENT TO RIVER.') 00127800
	PRINT 345,011T 00127900
345	FORMAT(1X, TREATED WASTEWATER FLOW RATE :', F7.3, 'MGD') 00128000
	PRINT 355, BOD11T 00128100
355	FORMAT(1X, 'TREATED WASTEWATER BOD EFFLUENT CONCENTRATION :', F5.1, '00128200
	*MG/L') 00128300
	PRINT 365,Q41T 00128400
365	
375	PRINT 375, BOD41T 00128600 FORMAT(1X, 'WITHOUT TREATMENT WASTEWATER BOD EFFLUENT CONCENTRATION00128700
3/5	* :',F5.1,'MG/L') 00128800
	GO TO 325 00128900
109	PRINT 385 00129000
385	FORMAT(' 8. DISCHARGE WITH PERMIT') 00129100
	PRINT 395,04IT 00129200
395	FORMAT(1X, DISCHARGE WASTEWATER FLOW RATE :', F7.3, 'MGD') 00129300
	PRINT 405, BOD41T 00129400
405	FORMAT(1X, 'EXPECTED BOD EFFLUENT CONCENTRATION :', F5.1,' MG/L')00129500
325	RETURN 00129600
	END 00129700
-	00129800
с	THIS SUBROUTINE IS USED FOR UPGRADING EXISTING PLANT 00129900
	SUBROUTINE UPGRAD(IFLAG, DQIT, DBODIT, FQIT, FBODIT) 00130000 IFLAG=0 00130100
	IFLAG=0 00130100 IN=0 00130200
с	SHOW BASIC INFORMATION 00130280
-	PRINT 105 00130400
105	FORMAT(' UPGRADE EXISTING PLANT') 00130500
	00120600
115	FORMAT(' CURRENT DESIGN CAPACITY :'.F7.3,'MGD') 00130700
-	PRINT 125, DB0D1T 00130800
125	FORMAT(' CURRENT DESIGN BOD EFFLUENT CONCENTRATION :'.F5.1.' MG/L00130900
	*') 00131000
	PRINT 135, SQIT 00131100
135	FORMAT(' THE MAXIMUM LIMITATION OF WASTEWATER FLOW RATE TO THE RIVOOI31200
	*ER :',F7.3,'MGD') 00131300

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	PRINT 136, SBODIT 00131400
. 36	FORMAT(' THE MAXIMUM LIMITATION OF BOD EFFLUENT CONCENTRATION TO TO0131500
	*HE RIVER :', F5.1,' MG/L') 00131600
	CALL YESNO(IA) 00131700
	IF (IA.EQ.2) GO TO 102 00131800
	GET INPUT DATA 00131900
04	PRINT 145 00132000
45	FORMAT(1X,'ENTER FUTURE DESIGN CAPACITY (MGD)') 00132100
	READ*, FQIT 00132200
	IF (IN.EQ.1) GO TO 109 00132300
107	PRINT 155 00132400
155	FORMAT(1X, ENTER FUTURE DESIGN BOD EFFLUENT CONCENTRATION (MG/L)')00132500
	READ*, FBODIT 00132600
	IF (IN_EQ.2) GO TO 109 00132700
101	PRINT 100 00132800
.00	FORMAT(' THIS IS YOUR UPGRADE PLAN') 00132900
	PRINT 165, FQIT 00133000
.65	FORMAT(' 1.FUTURE DESIGN CAPACITY :',F7.3,'MGD')00133100
	PRINT 175, FBODIT 00133200
. 75	FORMAT(' 2.FUTURE DESIGN BOD EFFLUENT CONCENTRATION :', F5.1,' MG/00133300
	*L') 00133400
	MAKE CORRECTION 00133500
.08	PRINT 185 00133600
.85	FORMAT(' IS THIS CORRECT') 00133700
.03	PRINT 195 00133800
.95	FORMAT('ENTER 1 IF CORRECT') 00133900
	PRINT 205 00134000
105	
-05	
215	
-15	
	READ*, IC 00134400
	GO TO (265,106,102),1C 00134500
_	PRINT 225,1C 00134600
225	FORMAT(' WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A00134700
	* REASONABLE VALUE') 00134800
	GO TO 103 00134900
.06	PRINT 235 00135000
235	FORMAT(1X, 'TYPE VARIABLE NUMBLE TO BE CHANGED') 00135100
	PRINT 245 00135200
245	FORMAT(1X, FOR EXAMPLE: TYPE 1 FOR FUTURE DESIGN CAPACITY') 00135300
	READ*, IN 00135400
	IF (IN.EQ.1) GO TO 104 00135500
	IF (IN.EQ.2) GO TO 107 00135600
	PRINT 255, IN 00135700
255	FORMAT(' WARNING:', 12.' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A00135800
	* REASONABLE VALUE') 00135900
	GD TO 106 00136000
_09	PRINT 335 00136100
335	FORMAT('ENTER 1 IF CORRECT') 00136200
100	PRINT 345 00136300
345	FORMAT(' ENTER 2 IF NEED TO MAKE MORE CORRECTION') 00136400
245	
	READ*, IB 00136500
	IF (IB.EQ.1) GO TO 101 00136600
	IF (IB.EQ.2) GO TO 106 . 00136700
	PRINT 355,IB 00136800
355	FORMAT(' WARNING:', 12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT A00136900
	* REASONABLE VALUE') 00137000
	GO TO 109 00137100
265	IF (FQIT.GE.DQIT) GO TO 285 00137200
	PRINT 275, FQIT, DQIT 00137300
275	FORMAT(' WARNING: FUTURE DESIGN CAPACITY', F7.3, 'MGD LESS THAN THE 00137400
	*CURRENT DESIGN CAPACITY', F7.3, 'MGD') 00137500
	PRINT 276 00137600
276	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO 000137700
	*UIT UPGRADE PLAN') 00137800
	READ*,FLG 00137900

.

	IF (FLG.GE.0.) GO TO 295	00138000
102	IFLAG=1	00136100
	FOIT=0.	00138200
	FBODIT=0.	00138300
	GO TO 325	
205		00138400
295	FQIT=FLG	00138500
	GO TO 101	00138600
285	IF (FBODIT.LE.DBODIT) GO TO 325	00138700
	PRINT 305, FBODIT, DBODIT	00138800
305	FORMAT(' WARNING: FUTURE DESIGN BOD EFFLUENT CONCENTRATION', F5.1.	'00138900
	*MG/L LARGER THAN CURRENT DESIGN BOD EFFLUENT CONCENTRATION', F5.1	'00139000
	*MG/L')	00139100
	PRINT 306	00139200
306	FORMAT(' PLEASE INPUT & REASONABLE VALUE OR ENTER -1 TO	
	*UIT UPGRADE PLAN')	00139400
	READ*, FLG	00139500
	IF (FLG.GE.0.) GO TO 315	00139600
	GO TO 102	00139700
315	FBODIT=FLG	00139800
310	GO TO 101	00139900
325		
325	RETURN	00140000
	END	00140100
_		00140200
c	THIS SUBROUTINE IS USED FOR PRINTING UPGRADE PLAN	00140300
	SUBROUTINE SHUPGR(FQIT, FBODIT)	00140400
	PRINT 105	00140500
105	FORMAT(' THIS IS YOUR UPGRADE PLAN')	00140600
	PRINT 115,FQIT	00140700
115	FORMAT(' FUTURE DESIGN CAPACITY :', F7.3, 'MGD')	00140800
	PRINT 125, FBODIT	00140900
125	FORMAT(' FUTURE DESIGN BOD EFFLUENT CONCENTRATION :', F5.1,' MG/I	00141000
	*)	00141100
	RETURN	00141200
	END	00141300
		00141400
c	THIS SUBBOUTINE IS USED FOR CORRECTING INDUT	00141400
с	THIS SUBROUTINE IS USED FOR CORRECTING INPUT	00141500
-	SUBROUTINE CORT(IB)	00141500 00141600
155	SUBROUTINE CORT(IB) PRINT 105	00141500 00141600 00141700
-	SUBROUTINE CORT(IB) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT')	00141500 00141600 00141700 00141800
155 105	SUBROUTINE CORT(IB) PRINT 105 Format(1x,'Enter 1 if correct') PRINT 115	00141500 00141600 00141700 00141800 00141800
155	SUBROUTINE CORT(IB) PRINT 105 Format(1%,'Enter 1 IF Correct') PRINT 115 Format(1%,'Enter 2 IF NEED TO MAKE & Change')	00141500 00141600 00141700 00141800 00141900 00142000
155 105	SUBROUTINE CORT(IB) PRINT 105 FORMAT(IX,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(IX,'ENTER 2 IF NEED TO MAKE & CHANGE') READ',IB	00141500 00141600 00141700 00141800 00141900 00142000 00142000
155 105	SUBROUTINE CORT(IB) PRINT 105 FORMAT(IX,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(IX,'ENTER 2 IF NEED TO MAKE & CHANGE') READ',IB IF (IB.EQ.1) GO TO 135	00141500 00141600 00141700 00141800 00141900 00142000 00142100 00142200
155 105	SUBROUTINE CORT(IB) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (IB.EQ.2) GO TO 135 IF (IB.EQ.2) GO TO 135	00141500 00141600 00141700 00141800 00141900 00142000 00142100 00142200 00142300
155 105 115	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,1B	00141500 00141600 00141700 00141800 00142000 00142000 00142000 00142200 00142300 00142400
155 105	SUBROUTINE CORT(IB) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(IX,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (IB.EQ.1) GO TO 135 IF (IB.EQ.2) GO TO 135 IF (IB.EQ.2) GO TO 135 PRINT 145,IB FORMAT('WARNING',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT	00141500 00141600 00141700 00141800 00142000 00142000 00142100 00142200 00142200 00142400 A00142500
155 105 115	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ',1B IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE')	00141500 00141600 00141700 00141800 00142000 00142000 00142200 00142200 00142300 00142400 A00142500 00142600
155 105 115 145	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,IB FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155	00141500 00141600 00141700 00141800 00142000 00142100 00142200 00142300 00142400 A00142500 00142400 A00142500 00142700
155 105 115	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN	00141500 00141600 00141700 00141800 00142000 00142000 00142200 00142200 00142300 00142400 A00142500 00142600
155 105 115 145	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,IB FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155	00141500 00141600 00141700 00141800 00142000 00142100 00142200 00142300 00142400 A00142500 00142400 A00142500 00142700
155 105 115 145	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN	00141500 00141600 00141700 00141800 00142000 00142000 00142200 00142200 00142300 00142300 00142500 00142500 00142800
155 105 115 145	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN	00141500 00141700 00141700 00141900 00142000 00142000 00142200 00142200 00142300 00142500 00142600 00142600 00142800 00142800
155 105 115 145	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FFINT 145,IB FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END	00141500 00141400 00141700 00141900 00142000 00142100 00142300 00142400 00142400 00142500 00142700 00142900 00143000
155 105 115 145 135	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,IB FORMAT('WARNING!',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO "	00141500 00141700 00141700 00141900 00142000 00142200 00142200 00142200 00142400 00142400 00142500 00142700 00142800 00143100 00143200
155 105 115 145 135	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE A CHANGE') READ', IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO "	00141500 00141400 00141700 00141900 00142000 00142100 00142100 00142200 00142400 00142400 00142600 00142800 00142800 00143100 00143100
155 105 115 145 135	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,1B FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105	$\begin{array}{c} 00141500\\ 00141600\\ 00141700\\ 00142000\\ 00142100\\ 00142100\\ 00142100\\ 00142200\\ 00142300\\ 00142300\\ 00142500\\ 00142500\\ 00142500\\ 00142900\\ 00143000\\ 00143000\\ 00143200\\ 0014300\\ 001400\\ 001400\\ 000\\ 000\\ 000\\ 000\\ $
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,1B FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105	00141500 00141400 00141700 00141900 00142000 00142100 00142100 00142300 00142300 00142500 00142500 00142800 00142800 00143100 00143100 00143100 00143500
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,IB FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105 FORMAT(1X,'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE')	00141500 00141700 00141700 00142000 00142000 00142100 00142100 00142200 00142300 00142300 00142500 00142500 00142500 00142800 00143100 00143100 00143400 00143600
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE & CHANGE') READ', IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER'3 AD FORMAT(1X,'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD	00141500 00141400 00141800 00141900 00142100 00142100 00142100 00142200 00142300 00142500 00142500 00142600 00142800 00143000 00143100 00143100 00143500 00143500 00143500
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,1B FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION "YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105 FORMAT(1X,'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(A3)	00141500 00141700 00141700 00142000 00142100 00142100 00142100 00142200 00142300 00142300 00142500 00142500 00142900 00142900 00143000 00143000 00143500 00143500
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE & CHANGE') READ', IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD FORMAT(1X, 'ENTER "YES' OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(23) IF (AD.EQ.'YES') GO TO 102	$\begin{array}{c} 00141500\\ 00141600\\ 00141800\\ 00141900\\ 00142000\\ 00142100\\ 00142100\\ 00142100\\ 00142100\\ 00142300\\ 00142300\\ 00142500\\ 00142800\\ 00142800\\ 00143000\\ 00143100\\ 00143100\\ 00143100\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143900\\ 001490\\ 001490\\ 001490\\ 001490\\ 001490\\ 001490\\ 001490\\ 001490\\ 001490\\ 001400\\ 001490\\ 001490\\ 001490\\ 000\\ 001490\\ 000\\ 001490\\ 000\\ 000\\ 000\\ 000\\ 000\\ 000\\ 000\\ $
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE A CHANGE') READ*,1B IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 PRINT 145,1B FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105 FORMAT(1X, 'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(33) IF (AD.EQ.'NO') GO TO 103	$\begin{array}{c} 00161500\\ 00141700\\ 00141700\\ 00142000\\ 00142000\\ 00142100\\ 00142100\\ 00142200\\ 00142300\\ 00142300\\ 00142300\\ 00142300\\ 00142500\\ 00142500\\ 00142900\\ 00142900\\ 00143000\\ 0014300\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 000\\ 0$
155 105 115 145 135 C 105 101 31	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X,'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X,'ENTER 2 IF NEED TO MAKE & CHANGE') READ*,1B IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105 FORMAT(1X,'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(A3) IF (AD.EQ.'YES') GO TO 102 IF (AD.EQ.'NO ') GO TO 103 PRINT 15	$\begin{array}{c} 00161500\\ 00141600\\ 00141800\\ 00141900\\ 00142000\\ 00142100\\ 00142100\\ 00142100\\ 00142200\\ 00142300\\ 00142500\\ 00142500\\ 00142500\\ 00142600\\ 00142600\\ 00142800\\ 00143000\\ 00143100\\ 00143100\\ 00143200\\ 00143500\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00144100\\ \end{array}$
155 105 115 145 135 C	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE A CHANGE') READ', IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING!',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION "YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD FORMAT(1X, 'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(1X, 'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(1X, 'ENTER "YES" OR "NO" ')	$\begin{array}{c} 00141500\\ 00141700\\ 00141700\\ 00141900\\ 00142000\\ 00142100\\ 00142200\\ 00142300\\ 00142300\\ 00142300\\ 00142300\\ 00142300\\ 00142500\\ 00142500\\ 00142600\\ 00143200\\ 00143200\\ 0014300\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143600\\ 00143600\\ 00143600\\ 00144000\\ 00144200\\ 0014400\\ 00144200\\ 0014400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 00140\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 000\\ 0$
155 105 115 145 135 C 105 101 31	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE & CHANGE') READ*, IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING:',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION " YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD PRINT 105 FORMAT(1X, 'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(13) IF (AD.EQ.'NO') GO TO 102 IF (AD.EQ.'NO') GO TO 103 FORMAT(1X, 'ELEASE TYPE "YES" OR "NO"') GC TO 101	$\begin{array}{c} 00161500\\ 00141700\\ 00141800\\ 00141800\\ 00142000\\ 00142100\\ 00142100\\ 00142100\\ 00142200\\ 00142300\\ 00142500\\ 00142500\\ 00142500\\ 00142900\\ 00142800\\ 00143100\\ 00143100\\ 00143200\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00143900\\ 00144300\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 0014400\\ 001400\\ 001400\\ 001400\\ 001400\\ 000\\ 0$
155 105 115 145 135 C 105 101 31	SUBROUTINE CORT(1B) PRINT 105 FORMAT(1X, 'ENTER 1 IF CORRECT') PRINT 115 FORMAT(1X, 'ENTER 2 IF NEED TO MAKE A CHANGE') READ', IB IF (1B.EQ.1) GO TO 135 IF (1B.EQ.2) GO TO 135 FORMAT('WARNING!',12,' EXCEEDS THE BOUNDARY VALUE PLEASE INPUT * REASONABLE VALUE') GO TO 155 RETURN END THIS SUBROUTINE IS USED FOR OPTION "YES OR NO " SUBROUTINE YESNO(1X) CHARACTER*3 AD FORMAT(1X, 'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(1X, 'ENTER "YES" OR "NO" TO CONFIRM YOUR CHOICE') READ(5,31) AD FORMAT(1X, 'ENTER "YES" OR "NO" ')	$\begin{array}{c} 00141500\\ 00141700\\ 00141700\\ 00141900\\ 00142000\\ 00142100\\ 00142200\\ 00142300\\ 00142300\\ 00142300\\ 00142300\\ 00142300\\ 00142500\\ 00142500\\ 00142600\\ 00143200\\ 00143200\\ 0014300\\ 00143500\\ 00143500\\ 00143500\\ 00143500\\ 00143600\\ 00143600\\ 00143600\\ 00144000\\ 00144200\\ 0014400\\ 00144200\\ 0014400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 00140\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 001400\\ 000\\ 0$

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APPENDIX G

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INTERACTIVE FORTRAN PROGRAM FOR PROCTOR INPUT

* TSO FOREGROUND HARDCOPY ****	
AME=Ull502C.QUAL.CNTL	
THIS IS AN INTERACTIVE INPUT PROGRAM FOR INSTRUCTORS. THE	00000100
INSTRUCTOR HAS ONLY TO CHOOSE & SEASON INDEX (] FOR SPRING 2 FOR	00000200
SUMMER 3 FOR FALL AND 4 FOR WINTER) AND THE PROGRAM WILL CHOOSE	00000300
THE SUITABLE TEMPERATURE, BOD CONCENTRATION AND FLOW RATE	00000400
AUTOMATICALLY. THIS PROGRAM WILL READ POINT SOURCE FLOW RATE AND	00000500
BOD CONCENTRATION FROM STUDENT DECISION FILES. THE PROGRAM WILL B	E00000600
CREATED AS A LOAD MODULE AND EXECUTED BY TSO COMMAND LANGUAGE (00000700
SQUAL.CLIST). THE PROGRAM WILL GENERATE A WATER QUALITY FILE.	00000800
THIS DATA FILE WILL BE FED INTO QUAL-II PACKAGE TO PRODUCE WATER	00000900
QUALITY OF THE WHOLE REACH.	00001000
	00001100
	00001200
INITIAL CONDITIONS :	00001300
TMPI(I,J) -> TEMPERATURE (*C) REACH I, SEASON J.	00001400
BODIN(1) -> BOD CONCENTRATION (MG/L) REACH I.	00001500
DOIN(I) -> DO CONCENTRATION (MG/L) REACH 1.	00001600
INCREMENTAL CONDITIONS :	00001700
TMP(J) -> TEMPERATURE (*C) SEASON J.	00001800
FLI(I,J) -> FLOW RATE (CMS) REACH 1, SEASON J.	00001900
BODIC(1) -> BOD CONCENTRATION (MG/L) REACH 1.	00002000
DOIC(1) -> DO CONCENTRATION (MG/L) REACH I.	00002100
HEADWATER CONDITIONS :	00002200
TMPH(1,J) -> TEMPERATURE (+C) HEADWATER I, SEASON J.	00002300
FLH(I,J) -> FLOW RATE (CMS) HEADWATER I, SEASON J.	00002400
BODH(I) -> BOD CONCENTRATION (MG/L) HEADWATER I. DOH(I) -> DO CONCENTRATION (MG/L) HEADWATER I.	000C2500 00002600
POINT SOURCE CONDITIONS:	00002700
TMPP(1, J) -> TEMPERATURE (*C) POINT SOURCE I, SEASON J.	00002800
DTP(J) -> DRY BULB TEMPERATURE (*C) SEASON J.	00002900
$WTP(J) \rightarrow WET BULB TEMPERATURE (*C) SEASON J.$	00003000
CH -> CONVERSION FACTOR 1 MGD IS EQUAL TO 1.55 CFS.	00003100
CVH -> CONVERSION FACTOR 1 CFS IS EQUAL TO 0.0283 CM5.	00003200
	00003300
	00003400
DIMENSION IS(7),Q1(7),BOD1(7),Q2(7),BOD2(7),Q3(7),BOD3(7),Q4(7),	00003500
*BOD4(7),UQ(7),UBOD(7),PFL(7),PBOD(7),FQ(7),FBOD(7),TMPI(5,4),	00003600
*BODIN(5), TMP(4), FLI(5,4), BODIC(5), TMPH(3,4), FLH(3,4), BODH(3),	00003700
<pre>*TMPP(7,4),DTP(4),WTP(4),SBOD(7),CBOD(7),DOIN(5),DOIC(5),DOH(3),</pre>	00003800
*PD0(7)	00003900
	00004000
CHARACTER*1 AR, AP	00004100
DATA TMP1/5*22.,5*26.,5*9.,5*6./	00004200
DATA BODIN/20.,43.,46.,37.,27./	00004300
DATA DOIN/20.,43.,46.,47.,27./	00004400
DATA TMP/20.,24.,7.,4./	00004500
DATA FL1/0.16,0.08,0.03,0.02,0.02,0.09,0.05,0.019,0.12,0.12,	00004600
*0.13,0.07,0.024,0.016,0.016,0.11,0.06,0.021,0.014,0.014/	00004700
DATA BODIC/5*60./	00004800
DATA TMPH/3*22.,3*26.,3*9.,3*6./	00005000
DATA FLH/1.3,0.11,0.23,0.78,0.07,0.14,0.14,0.09,0.18,0.9,0.08,0.1 */	00005100
DATA BODH/3*20./	00005200
	00005300
DATA TMPP/23.,22.,23.,22.,23.,22.,22.,27.,26.,27.,26.,27.,26.,26. *10.,9.,10.,9.,10.,9.,9.,7.,6.,7.,6.,7.,6.,6./	00005600
DATA WTP/22.,26.,9.,6./	00005700
DATA DTP/26.,30.,13.,10./	00005800
CH=1.55	00006000
	00006100
CONVERT FROM METRIC UNIT YO ENGLISH UNIT	00006200
	00000200

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		DO 15 I=1,4	00006300
		TMP(I)=TMP(I)*1.8+32	00006301
		DTP(I)=DTP(I)*1.8+32	00006302
		WTP(I)=WTP(I)*1.8+32	00006303
		DO 16 J=1,3	00006310
		TMPH(J,I) = TMPH(J,I) * 1.8 + 32	00006311
		FLH(J,I) = FLH(J,I) * 0.03	00006320
	16	CONTINUE	00006330
		DO 17 J≈1.5	00007100
		TMPI(J,I)=TMPI(J,I)=1.6+32	00007200
		FLI(J,I)=FLI(J,I)*35.3	00007300
	17		00007400
		DO 18 J=1,7	00007500
		TMPP(J,I) = TMPP(J,I) * 1.8 + 32	00007600
	18	CONTINUE	00007700
	15	CONTINUE	00007800
			00007900
С		GET SEASON INDEX	00080000
		PRINT 49	00008100
	49	FORMAT(' ENTER SEASON INDEX> 1 FOR SPRING 2 FOR SUMMER 3 FOR FA	\$00006200
		*LL AND 4 FOR WINTER')	00006300
		READ*, J	00008400
С		READ STUDENT DECISION FILES	00008500
		DO 23 I=1,7	00008600
		READ(14+1.45) AR.IT.IJ.IS(1).AP.PR.PC.PRBOD.O1(1).BOD1(1).O2(1).	00005700
		<pre>READ(14+1,45) AR,IT,IJ,IS(1),AP,PR,PQ,PRBOD,Q1(1),BOD1(1),Q2(1), * BOD2(1),Q3(1),BOD3(1),Q4(1),BOD4(1),UQ(1),UBOD(1),FBOD(1),FBOD(1),</pre>	00008800
		*SBOD(I),CBOD(I)	0008900
	45	FORMAT(A1,311,A1,F6.3,6(F6.3,F5.1)/F6.3,3F5.1)	00009000
	23	CONTINUE	00009100
		WRITE (11,50)	00005200
	50		00009300
		WRITE(11,51) AR, AP	00009400
	51	FORMAT('TITLE02',14%, 'REGION',1%,A1,3%, 'PERIOD',1%,A1)	00009500
		WRITE(11,52)	00009600
	52	FORMAT('TITLE03', 3X, 'NO', 9X, 'CONSERVATIVE MINERAL I')	00009700
		WRITE(11,53)	00009800
	53	FORMAT('TITLE04', 3%, 'NO', 9%, 'CONSERVATIVE MINERAL 11')	00009900
		WRITE(11,54)	00010000
	54	FORMAT('TITLE05', 3%, 'NO', 9%, 'CONSERVATIVE MINERAL III')	00010100
		WRITE(11,55)	00010200
	55	FORMAT('TITLE06',2%,'YES',9%,'TEMPERATURE')	00010300
		WRITE(11,56)	00010400
	56	FORMAT('TITLE07', 2X, 'YES', 9X, 'BIOCHEMICAL OXYGEN DEMAND IN MG/L')	00010500
		WRITE(11,57)	00010600
	57	FORMAT('TITLEO8',3X,'NO',9X,'ALGAE AS CHL A IN UG/L')	00010700
		WRITE(11,58)	00010800
	5B	FORMAT('TITLE09', 3X, 'NO', 9X, 'PHOSPHORUS AS P IN MG/L')	00010900
		WRITE(11,59)	00011000
	59	FORMAT('TITLE10',3%,'NO',9%,'AMMONIA AS N IN MG/L')	00011100
		WRITE(11,60)	00011200
	60	FORMAT('TITLE11',3X,'NO',9X,'NITRITE AS N IN MG/L')	00011300
		WRITE(11,61)	00011400-
	61	FORMAT('TITLE12', 3X, 'NO', 9X, 'NITRATE AS N IN MG/L')	00011500
		WRITE(11,62)	00011600
	62	FORMAT('TITLE13', 2X, 'YES', 9X, 'DISOLVED OXYGEN IN MG/L')	00011700
		WRITE(11,63)	00011800
	63	FORMAT('TITLE14', 3X, 'NO', 9X, 'COLIFORMS IN NO/100 ML')	00011900
		WRITE(11,64)	00012000
	64	FORMAT('TITLE15', 3X, 'NO', 9X, 'ARBITRARY NON-CONSERVATIVE')	00012100
		WRITE(11,65)	00012200
	65	FORMAT('ENDTITLE')	00012300
		WRITE(11,66)	00012400
	66	FORMAT('LIST DATA INPUT')	00012500
		WRITE(11,67)	00012600
	67		00012700
		WRITE(11,66)	00012800

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68	FORMAT('NO FLOW AUGMENTATION') 000129
9	WRITE(11,69) 000130 FORMAT('STEADY STATE') 000131
	WRITE(11,70) 000132
0	FORMAT('NO TRAPEZOIDAL X-SECTION') 000133 WRITE(11,71) 000134
1	FORMAT('INPUT METRIC (VES=))'.4X.'=' 9X.'0' 10X 'OUTPUT METRIC (VECCOL35)
	*5-1)', 3X, '=', 9X, '0') 000136 WRITE(11,72) 000137
2	FORMAT('NUMBER OF REACKES', 7X, '=', 9X, '5', 10X, 'NUMBER OF JUNCTIONS'000138
	*,5X,'=',9X,'2') 000139 WRITE(11,73) 000140
3	FORMAT('NUM OF HEADWATERS', 7X, '=', 9X, '3', 10X, 'NUMBER OF POINT LOAD000141
	*5', 3X, '=', 9X, '7') WRITE(11, 74) 000142
4	FORMAT('TIME STEP (HOURS)',7%,'=',20%,'LNTH COMP ELEMENT (MI)=',000144
	*9X,'1') 000145 WRITE(11,75) 000146
5	FORMAT('MAXIMUM ROUTE TIME (HRS)=',8X,'30',10X,'TIME INC, FOR RPT2000147
	* (HRS)=') 000148 WRITE(11,120) 000149
0	FORMAT('LATITUDE OF BASIN (DEG) =',6X,'42.5',10X,'LONGITUDE OF BAS000150 *IN (DEG)=',6X,'83.3') 000151
	WRITE(11,121) 000152
1	FORMAT('STANDARD MERIDIAN (DEG) =',6X,'75.0',10X,'DAY OF YEAR STAR0001531 *T TIME =',5X,'180.0') 0001541
	WRITE(11,122) 000155
2	FORMAT('EVAP. COEF. (AE)',8X,'=',2X,'.0000062',10X,'EVAP. COEF. (B000156' *E)',6X,'=',2X,'.0000055') 000157
	WRITE(11,123) 000158
3	FORMAT('ELEV. OF BASIN (METERS)',1X,'=',6X,'250.',10X,'DUST ATTENU000159 *ATION COEF.',2X,'=',6X,'0.13') 000160
	WRITE(11,76) 000161
6	FORMAT('ENDATA1') 000162 WRITE(11,77) 000163
7	FORMAT('ENDATAIA') 000164
78	WRITE(11,78) 000165 FORMAT('STREAM REACH',5X,'1.0RCH=',19X,'FROM',9X,'46.0',4X,'TO',10000166
	*X, '30.') 000167
79	WRITE(11,79) 000168 FORMAT('STREAM REACH',5X,'2.0RCH=',19X,'FROM',9X,'14.0',4X,'TO',10000169
	*X, '10.') 000170
0	FORMAT('STREAM REACH', 5X, '3.0RCH=', 19X, 'FROM', 10X, '3.0', 4X, 'TO', 11000172
	*X,'0.') 000173 WRITE(11,81) 000174
1	FORMAT('STREAM REACH', 5%, '4.0RCH=', 19%, 'FROM', 9%, '10.0', 4%, 'TO', 11000175
	*X,'0.') 000176 WRITE(11,62) 000177
12	FORMAT('STREAM REACH', 5X, '5.0RCH=', 19X, 'FROM', 9X, '30.0', 4X, 'TO', 10000178
	*X,'18.') 000179 WRITE(11,83) 000180
3	FORMAT('ENDATA2') 000181
4	WRITE(11,84) 000182 FORMAT('ENDATA3') 000183
	WRITE(11,85) 000184
5	FORMAT('FLAG FIELD RCH=',2X,'1.0',6X,'16.0',10X,'1.2.2.6.2.2.2.6.2000185 *.2.2.2.2.6.2.3.') 000186
	WRITE(11,86) 000187
6	FORMAT('FLAG FIELD RCH=',2X,'2.0',7X,'4.0',10X,'1.6.2.3.') 000188(WRITE(12,87) 000189
17	FORMAT('FLAG FIELD RCH=',2X,'3.0',7X,'3.0',10X,'1.6.2.') 0001901
8	WRITE(11,88) 000191 FORMAT('FLAG FIELD RCH=',2X,'4.0',6X,'10.0',10X,'4.2.2.2.2.2.2.6.2.2000192
2	*.2.') 0001934
	WRITE(11,69) 000194

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89	FORMAT('FLAG FIELD RCH=',2%,'5.0',6%,'12.0',10%,'4.2.2.2.2.6.2.2.	200019500
	*.2.2.5.')	00019600
	WRITE(11,90)	00019700
90	FORMAT('ENDATA4')	00019800
	WRITE(11,91)	00019900
91	FORMAT('HYDRAULICS RCH=',2X,'1.0',15X,'.2500',5X,'0.300',5X,'0.44	00020000
	*',6%,'0.55',5%,'0.040')	00020100
	WRITE(11,92)	00020200
92		000020300
	*',6X,'0.61',5X,'0.040')	00020400
	WRITE(11,93)	00020500
93		
	*', 6X, '0.5B', 5X, '0.040')	00020700
	WRITE(11,94)	00020800
94	FORMAT('HYDRAULICS RCH=', 2X, '4.0', 15X, '.3800', 5X, '0.370', 5X, '0.51	
	*',6X,'0.61',5X,'0.040') WRITE(11,95)	00021000 00021100
95		
55	*',6X,'0.38',5X,'0.040')	00021300
	WRITE(11.96)	00021400
96	FORMAT('ENDATA5')	00021500
	WRITE(11,97)	00021600
97	FORMAT('REACT COEF RCH=',2X,'1.0',6X,'0.60',7X,'0.0',7X,'2.0')	00021700
	WRITE(11,98)	00021800
9B	FORMAT('REACT COEF RCH=',2X,'2.0',6X,'0.60',7X,'0.0',7X,'2.0')	00021900
	WRITE(11,99)	00022000
99		00022100
	WRITE(11,100)	00022200
100	FORMAT('REACT COEF RCH=',2X,'4.0',6X,'0.60',7X,'0.0',7X,'2.0')	00022300
1.01	WRITE(11,101)	00022400
101	FORMAT('REACT COEF RCH=',2X,'5.0',6X,'0.60',7X,'0.0',7X,'2.0')	00022500 00022600
102	WRITE(11,102) Format('Endata6')	00022700
101	WRITE(11,103)	00022800
103		00022900
	WRITE(11,104)	00023000
104	FORMAT('ENDATA6B')	00023100
с	INITIAL CONDITIONS	00023200
	DO 21 I=1,5	00023300
	WRITE(11,105) I,TMPI(1,J),DOIN(I),BODIN(I)	00023400
105		00023500
21	CONTINUE	00023600
100	WRITE(11,106)	00023700
106	FORMAT('ENDATA7') Write(11,107)	00023800
107		00024000
c	INCREMENTAL INFLOW	00024100
÷	DO 29 I=1,5	00024200
	WRITE(11,150) I,FLI(I,J),TMP(J),DOIC(I),BODIC(I)	00024300
150	FORMAT('INCREMENTAL INFLOW', 3X, 'RCH=', 4X, 11, F5.3, F5.1, F5.1, F5.1)	00024400
29	CONTINUE	00024500
	WRITE(11,108)	00024600
108	FORMAT('ENDATAB')	00024700
	WRITE(11,109)	00024800
109	FORMAT('ENDATABA')	00024900
	WRITE(11,110)	00025000
110	FORMAT('STREAM JUNCTION', 7X, '1.0', 5X, 'JNC=', 23X, '20.', 7X, '24.', 7X	
	*'23,')	00025200
	WRITE(11,111)	00025300
111	FORMAT('STREAM JUNCTION',7X,'2.0',5X,'JNC=',23X,'16.',7X,'34.',7X *'33.')	
	WRITE(11,112)	00025500 00025600
112	FORMAT('ENDATA9')	00025600
	DO 22 $I = 1,3$	00025800
	WRITE(11,113) I,FLH(I,J),TMPH(I,J),DOH(I),BODH(I)	00025900
113	FORMAT('HEADWATER', 10%, 11, 'HDW=', 16%, F10.3, F5.1, F5.1, F5.1)	00026000

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22	CONTINUE	00026100
	WRITE(11,114)	00026200
214	FORMAT('ENDATA10')	00026300
	WRITE(11,115)	00026400
115	FORMAT('ENDATA10A')	00026500
	POINT SOURCE LOADING	00026600
	DO 24 I=1,5	00026700
	GO TO (131,132,132,131,132,133,134,133),IS(1)	00026800
131	PFL(1)=Q1(1)	00026900
	PBOD(I) = BODI(I)	00027000
	GO TO 24	00027100
132	PFL(I)=0.	00027200
	PBOD(1)=0.	00027300
	GO TO 24	00027400
133	PFL(1)=04(I)	00027500
	PBOD(I)=BOD4(I)	00027600
	GO TO 24	00027700
134	PFL(I)=Q1(I)+Q4(I)	00027800
	PBOD(I) = (Q1(I) * BOD1(I) + Q4(I) * BOD4(I)) / (Q1(I) + Q4(I))	00027900
24	CONTINUE	00028000
		00028100
	CALCULATE FLOW RATES AND BOD CONCENTRATION FOR MUNICIPAL TREATMENT	00028200
	PLANTS	00028300
	DO 25 I=1,3	00028400
	PFL(6)=Q2(1)+Q3(1)+PFL(6)	00028500
25	CONTINUE	00028600
	DO 26 I=4,5	00028700
	PFL(7)=Q2(I)+Q3(I)+PFL(7)	00028800
26	CONTINUE	00028900
	DO 27 I=6,7	00029000
	PFL(I) = PFL(I) + UQ(I)	00029100
	PBOD(I)=CBOD(I)	00029200
27	CONTINUE	00029300
	DO 28 I=1,7	00029400
28	PFL(I)=PFL(I)*CH	00029500
28	CONTINUE	00029600
	CONVERT TEAM SEQUENCE TO POINT LOAD SEQUENCE	00029700
	P=PFL(3)	00029900
	PFL(3)=PFL(6)	00030000
	PFL(6) = PFL(7)	00030100
	PFL(7)=P	00030200
	P=PBOD(3)	00030300
	PBOD(3)=PBOD(6)	00030400
	PBOD(6) = PBOD(7)	00030500
	PBOD(7)-P	00030600
	T=TMPP(3,J)	00030700
	TMPP(3,J)=TMPP(6,J)	00030800
	TMPP(6, J) = TMPP(7, J)	00030900
	TMPP(7,J)=T	00031000
		00031100
	CONVERT 1CFS TO 1 CMS	00031200
	DO 201 I=1,7	00031300
	PFL(I)=PFL(I)=0.0283	00031400
201	CONTINUE	00031500
	DO 30 I=1,7	00031600
	WRITE(11,116) I, PFL(I), TMPP(I, J), PDO(I), PBOD(I)	00031700
116		00031800
30	CONTINUE	00031900
	WRITE(11,117)	00032000
117	FORMAT('ENDATA11')	00032100
	WRITE(11,118)	00032200
118	FORMAT('ENDATA11A')	00032300
	WRITE(11,119) DTP(J), WTP(J)	00032400
9	FORMAT('LOCAL CLIMATOLOGY', 28X, '0.2', 3X, F5.1, 3X, F5.1, 2X, '1000.0', 5 *X, '3.0')	00032500
	ν α, β.ν /	00032600

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APPENDIX H

ALPHABETICAL LIST OF VARIABLES AND THEIR DEFINITIONS IN WATER QUALITY SIMULATION GAME

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- AR Region index
- ALM (I) Labor and Material cost, Firm I
- ABOD (I) BOD Effluent concentration to the treatment plant, Team I
- BOD1 (I) BOD effluent concentration treated from the industrial treatment plant to the river, Firm I
- BOD2 (I) BOD effluent concentration treated from the industrial treatment plant to the municipal treatment plant, Firm I
- BOD3 (I) BOD concentration sent without treatment from the industrial firm to the municipal treatment plant, Firm I
- BOD4 (I) BOD concentration discharged without treatment from the industrial firm to the river, Firm I
- BQ (I) Wastewater flow rate to the treatment plant, Team I
- C1 (I) Quarterly investment and fixed operation costs, Firm I
- CBOD (I) Municipal plant wastewater BOD effluent concentration, Team I
- DBOD (I) Current design BOD effluent concentration, Team I
- DQ (I) Current design capacity, Team I
- FBOD (I) Future design BOD effluent concentration, Team I
- FQ (I) Future design capacity, Team I
- I Dummy team number index
- IJ Industrial firm or municipal treatment plant index
- IP Period number index
- IS Alternative index
- NRG Seed of the uniformly distributed pseudo-random numbers
- OE (I) Other expenses of the industrial firm, Firm I
- PBOD (I) Wastewater BOD concentration produced, Firm I
- PC (I) Discharge without permit -> penalty costs, Firm I
- POE (I) Price of other expenses per unit products, Firm I
- PLA (I) Price of labor and material costs per unit product, Firm I

- PQ (I) Wastewater flow rate produced, Firm I
- Q1 (I) Wastewater flow rate pretreated from the industrial treatment plant to the river, Firm I
- Q2 (I) Wastewater flow rate pretreated from the industrial treatment plant to the municipal treatment plant, Firm I
- Q3 (I) Wastewater flow rate sent without treatment from the industrial firm to the municipal treatment plant, Firm I
- Q4 (I) Wastewater flow rate discharged from the industrial firm to the river, Firm I
- RANF Uniform distributed pseudo-random number function
- RAT (I) Design BOD removal rate, Team I
- SR (I) Total sales revenue, Firm I
- TC (I) Total expenses, Firm I
- TCI (I) Tax on current income, Firm I
- TNE (I) Total net earning, Firm I
- TPP (I) Total price of permits
- TTI (I) Total taxable income, Firm I
- UBOD (I) Residential wastewater BOD concentration, Team I
- UC (I) Industrial wastewater user charges, Team I
- UQ (I) Residential wastewater flow rate, Team I
- VC (I) Operation costs, Team I
- WC (I) Total water quality related costs, Team I.

APPENDIX I

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TRANSACTION RECORDS OF PERMITS

Team	# of Permits Bought	Buying Price	# of Permits Sold	Selling Price
1	<-1577	<-18.19	<-224	18.19->
2	<-14.2	<-38.67	<-76	38.67->
3	<-123	<-17.8	<-10	17.8->
4	<-26.66	<-43.88	<-6.66	43.88->
5	<-333.6	<-95.8	<-333.6	95.8->
6			<-625.5	5.0->
7				

The market model is based on multiple-price auction, negotiation between bidders and rationale bidder behavior.

Based on the above information, the administration decides the following trading transaction.

Team 1 will buy 10.0 permits at \$18 from Team 3 Team 1 will buy 250.7 permits at \$18 from Team 6 Team 2 will buy 14.2 permits at \$19 from Team 6 Team 3 will sell 10.0 permits at \$18 to Team 1 Team 4 will buy 26.7 permits at \$39 from Team 6 Team 5 will buy 333.6 permits at \$44 from Team 6 Team 6 will sell 250.7 permits at \$18 to Team 1 Team 6 will sell 14.2 permits at \$19 to Team 2 Team 6 will sell 26.7 permits at \$39 to Team 4 Team 6 will sell 26.7 permits at \$39 to Team 4

Team 、	<pre># of Permits Bought</pre>	Buying Price	# of Permits Sold	Selling Price
1	<-1678	<-17.73	<-213.7	17.73->
2	<-14.2	<-38.67	<-76	38.67->
3	<-157	<-17.8	<-10	17.8->
4	<-33	<-43.88	<-6.66	43.88->
5	<-333.6	<-85.8	<-333.6	85.8->
6			<-592.	5.0->
7				

Period 6

Based on the above information, the administration decides the following trading transactions.

Team 1 will buy 64.2 permits at \$17.78 from Team 6 Team 2 will buy 14.2 permits at \$18 from Team 6 Team 3 will buy 147.0 permits at \$17.78 from Team 6 Team 4 will buy 33.0 permits at \$39 from Team 6 Team 5 will buy 333.6 permits at \$44 from Team 6 Team 6 will sell 64.2 permits at \$17.78 to Team 1 Team 6 will sell 14.2 permits at \$18 to Team 2 Team 6 will sell 147.0 permits at \$17.78 to Team 3 Team 6 will sell 33.0 permits at \$39 to Team 4 Team 6 will sell 333.6 permits at \$44 to Team 5

Team	# of Permits Bought	Buying Price	# of Permits Sold	Selling Price
1	<-1839	<-17.73	<-197.7	17.73->
2	<-14.2	<-38.67	<-76	38.67->
3	<-180	<-17.8	<-10	17.8->
4	<-34.2	<-43.88	<-6.66	43.88->
5	<-333.6	<-85.8	<-333.6	85.8->
6			<-572.	5.0->
7	<-8.34	<-470.2		

Based on the above information, the administration decides the following trading transactions.

Team 2 will buy 14.2 permits at \$18 from Team 6 Team 3 will buy 180.0 permits at \$17.78 from Team 6 Team 4 will buy 34.2 permits at \$39 from Team 6 Team 5 will buy 333.6 permits at \$44 from Team 6 Team 7 will buy 8.34 permits at \$46 from Team 6 Team 6 will sell 14.2 permits at \$18 to Team 2 Team 6 will sell 180.0 permits at \$17.78 to Team 3 Team 6 will sell 34.2 permits at \$39 to Team 4 Team 6 will sell 333.6 permits at \$44 to Team 5 Team 6 will sell 333.6 permits at \$44 to Team 5

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Team	# of Permits Bought	Buying Price	# of Permits Sold	Selling Price
1	<-1910	<-17.13	<-181.4	17.73->
2	<-14.2	<-38.67	< - 76	38.67->
3	<-200.2	<-17.8	<-10	17.8->
4	<-40.7	<-43.88	<-6.66	43.88->
5	<-333.6	<-85.8	<-333.6	85.8->
6			<-558.	5.0->
7	<-8.34	<-470.2		

Based on the above information, the administration decides the following trading transactions.

Team 2 will buy 14.2 permits at \$18 from Team 6 Team 3 will buy 161.16 permits at \$17.78 from Team 6 Team 3 will buy 39.04 permits at \$17.78 from Team 1 Team 4 will buy 40.7 permits at \$39 from Team 6 Team 5 will buy 333.6 permits at \$44 from Team 6 Team 7 will buy 8.34 permits at \$86 from Team 6 Team 6 will sell 14.2 permits at \$18 to Team 2 Team 6 will sell 161.16 permits at \$17.78 to Team 3 Team 1 will sell 39.04 permits at \$17.78 to Team 3 Team 6 will sell 40.7 permits at \$39 to Team 4 Team 6 will sell 333.6 permits at \$44 to Team 5 Team 6 will sell 333.6 permits at \$44 to Team 5 Team 6 will sell 333.6 permits at \$44 to Team 7

Period 8

Shin An Chiang

Candidate for the Degree of

Doctor of Philosophy

Thesis: A WATER QUALITY MANAGEMENT SIMULATION GAME

Major Field: Civil Engineering

Biographical:

- Personal Data: Born in Taipei, Taiwan, June 5, 1950, the son of Chiang Yung Ching and Yu Wen Quey.
- Education: Received Bachelor of Science Degree in Engineering from National Cheng Kung University in July, 1973; Received Master of Science Degree from University of Wisconsin, Madison, in December, 1980; Completed requirements for the Doctor of Philosophy Degree at Oklahoma State University in December, 1986.
- Professional Experience: Research Assistant, Department of Civil Engineering, University of Wisconsin, July, 1978 to June, 1980; Research Assistant, Water Resource Research Center, Oklahoma State University, June, 1984 to December, 1986.