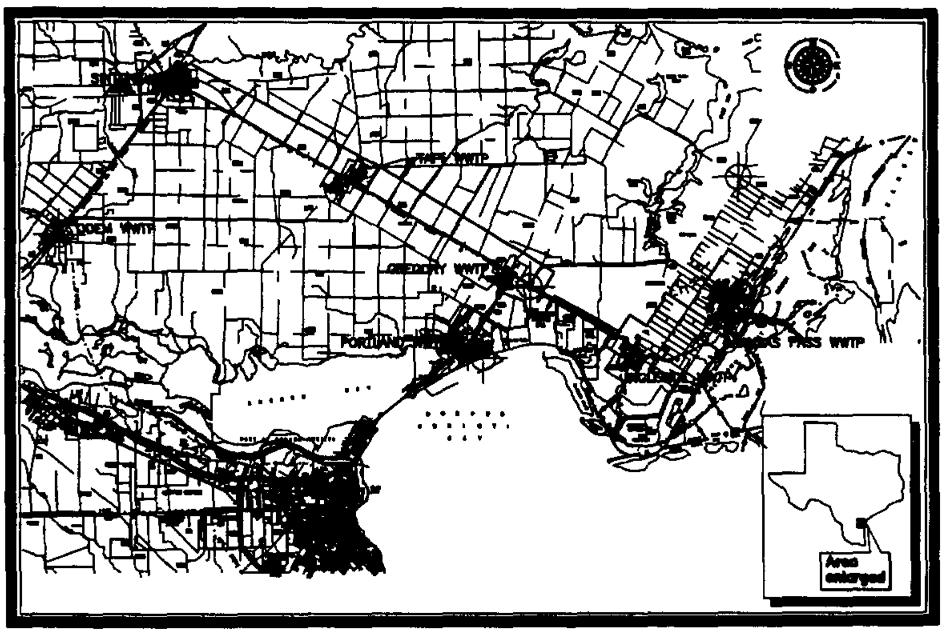
FINAL REPORT

NORTHSHORE REGIONAL WASTEWATER REUSE WATER SUPPLY AND FLOOD CONTROL PLANNING STUDY

PREPARED FOR

SAN PATRICIO MUNICIPAL WATER DISTRICT
INGLESIDE, TEXAS
AND
TEXAS WATER DEVELOPMENT BOARD



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THE CITIES OF ARANSAS PASS, GREGORY, TAFT, INGLESIDE, PORTLAND
ODEM, INGLESIDE ON THE BAY AND REYNOLDS METALS COMPANY,
OCCIDENTAL CHEMICAL CORPORATION AND E.I. DUPONT DE NEMOURS.

OCTOBER 1994

NORTHSHORE REGIONAL WASTEWATER REUSE, WATER SUPPLY, AND FLOOD CONTROL PLANNING STUDY -- SAN PATRICIO COUNTY, TEXAS

Prepared for:

The San Patricio Municipal Water District
Ingleside, Texas

The San Patricio County Drainage District
Sinton, Texas

The Cities of
Aransas Pass, Texas
Gregory, Texas
Taft, Texas
Ingleside, Texas
Portland, Texas
Odem, Texas
Ingleside on the Bay, Texas
and
Reynolds Metals Company
E.I. DuPont de Nemours & Company
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September, 1994

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Executive Summary

ES 1.0 INTRODUCTION

The 12-county Coastal Bend area of Texas depends upon the Choke Canyon/Lake Corpus Christi Reservoir System (CC/LCC System) for more than 80 percent of its municipal and industrial water. The area, which includes Corpus Christi and neighboring cities, including those in San Patricio County, had a population of 530,878 in 1990, and is projected to have more than one million inhabitants by 2040. In 1990, the population of San Patricio County was 58,749, and the county is projected to have a population of 98,000 to 109,000 by 2040. Industries that depend upon the CC/LCC System include approximately 14 percent of Texas petroleum refining capacity and 8.7 percent of Texas chemical production capacity.

Water supply and flooding are continual problems for large areas of San Patricio County. Most of the northshore study area of San Patricio County depends upon the San Patricio Municipal Water District (SPMWD) for its municipal and industrial water supply. The SPMWD obtains both treated water and raw water from the CC/LCC System. The City of Corpus Christi, principal owner of the CC/LCC System, is operating under a Texas Natural Resource Conservation Commission order which specifies a monthly schedule of inflows to Nueces Bay and which further directs that all wholesale customers and any subsequent wholesale customers shall develop and implement water conservation and drought contingency measures. The SPMWD is one of the wholesale customers to which these conditions apply.

It is important to note that demands upon the CC/LCC System are projected to exceed the supply available within eight to 10 years. In addition, it is equally important to note that the SPMWD's transmission system (water lines, pumps, and storage facilities) is presently operating at or near its 28 to 30 million gallons per day of capacity. Thus, the SPMWD is faced with a growing water demand and no way to meet either short-term or long-term needs without adding a new, 28-mile raw water line.

Drainage and flooding problems related to the Green Lake Outfall Structure have existed for many years. The drainage basin has 10.95 square miles of area upstream of the spillway structure at Green Lake. An inadequate primary outfall channel, combined with the inadequate structural and hydraulic capacity of the dam contributes to frequent flooding of the area located between the cities of Gregory and Portland, including the southwestern portions of the City of Gregory.

ES 2.0 OBJECTIVES AND GOALS

The principal objectives of this study are:

1) To identify and evaluate the potential to collect wastewater from municipalities of the study area and convey such wastewater to industry (Reynolds Metal in particular) for reuse, thereby reducing demands upon freshwater supplies; and

2) To evaluate the potential for development of flood management plans for the Green Lake outfall system and adjacent water courses.

The goals applicable to the study at the regional level are to: (1) Improve efficiency of use of fresh surface water resources; (2) Avoid unnecessary withdrawals from the CC/LCC reservoir system; (3) Provide benefits of scale in wastewater treatment; (4) Improve reliability of the regional water supply; and (5) Address flooding and drainage problems of the Green Lake watershed. For municipalities, the goals include: (1) Capping or reducing costs of wastewater treatment; (2) Improvement in reliability of water supply; (3) Reduced demands from wastewater operation on managerial staff time; and (4) Gaining better control of costs of wastewater collection, transmission, and treatment. In the case of industry, the goals contribute to: (1) Capping or reducing raw water costs; (2) Improvement in reliability of raw water supply; and (3) Increased participation in regional environmental improvement activities.

ES 3.0 WATER SUPPLY AND DEMAND

At the present time, the SPMWD has water supply capacity of about 30 mgd, and has only a small quantity of capacity that is in excess of the municipal water demands in peak months plus existing water supply contracts with industries. During peak demand situations, adjustments are made to control the quantity of water supplied to selected customers. Thus, the need for additional supplies that might be made available through reuse of municipal wastewater from local area cities. For example, Reynolds Metals uses 6.0 mgd of which 2.8 mgd is untreated water for tailings bed dust control for which wastewater effluent may be ideal.

On an average annual basis, Northshore Country Club's (NSCC's) irrigation water demand is 226 acre-feet, with approximately 175 acre-feet withdrawn from Green Lake and 51 acre-feet purchased from the City of Portland. NSCC has a water rights permit for withdrawal of irrigation water from Green Lake but, in five of the previous nine years, Green Lake was inadequate to meet NSCC's irrigation needs. Thus, NSCC's needs for additional water must also be taken into account.

ES 4.0 WASTEWATER EFFLUENT REUSE

Projected wastewater flows from study area cities in millions of gallons per day (mgd) are as follows:

City	Year 1990	2000 (mgd)	2010	2020
Aransas Pass	0.83	0.93	1.07	1.22
Gregory	0.18	0.24	0.30	0.35
Ingleside	0.38	0.47	0.55	0.63
Ingleside on the Bay	0.06	0.07	0.10	0.10
Odem	0.12	0.12	0.14	0.16
Portland	1.12	1.25	1.39	1.52
Sinton	0.47	0.53	0.61	0.69
Taft	0.46	0.52	0.55	0.58
TOTAL (mgd)	3.56	4.06	4.61	5.15

The quantities shown above represent the potential quantities that might be available for reuse if reuse is feasible from both economic and regulatory perspectives. A benefit-cost analysis of taking wastewater directly from each city's discharge point to Reynolds Metals Company for reuse showed that such a project would only be feasible for Portland whose benefit-cost ratio was 1.6 (Table ES-1).

ES 5.0 REGIONAL WASTEWATER COLLECTION, TREATMENT, AND REUSE

An economic evaluation of the feasibility of a regional wastewater collection, treatment, and reuse system was made based upon the following conditions:

- The total cost to each city for regional treatment would not exceed the existing cost of treatment with its own individual WWTP.
- Regional costs to be borne by each city include the cost to transport its untreated wastewater to the regional WWTP and a share of regional WWTP debt service and O & M costs, based on the contribution of flow as a percentage of the total flow.

TABLE ES-1
REGIONAL EFFLUENT FACILITIES BENEFIT-COST RATIO

City	Effluent Flow mgd[1]	Annual Benefit (In Thousands of Dollars)			Annual Cost (In Thousands of Dollars)			Benefit-Cost Ratio
		Value of Effluent	Savings in Plant Upgrade Cost	Total Benefit	Debt Service	O & M	Total Cost	
Portland	1.25	$183	$76	$259	$129	$35	$164	1.6
Gregory	0.24	$35	-	$35	$40	$19	$59	0.6
Aransas Pass	0.93	$136	$75	$211	$229	$39	$268	0.8
Ingleside	0.47	$69	-	$69	$119	$33	$152	0.5
Aransas Pass (combined with Ingleside)	0.93	$136	$75	$211	$222	$39	$261	0.8
Ingleside (combined with Aransas Pass)	0.47	$69	-	$69	$110	$29	$139	0.5
Taft	0.52	$76	-	$76	$142	$19	$161	0.5
Taft (combined with Sinton)	0.52	$76	-	$76	$83	$22	$105	0.7
Sinton (combined with Taft)	0.50	$73	-	$73	$196	$25	$221	0.3
Odem (combined with Taft and Sinton)	0.12	$18	-	$18	$165	$22	$187	0.1

[1]From Table 2-5.

Existing treatment costs for each city include:

- Outstanding annual debt service on existing treatment facilities.
- Annual O & M costs for existing treatment facilities (inflation costs were not considered in the evaluation).

Cost information for the above items was provided by each city. The following additional annual costs were considered in calculation of the overall total existing cost of treatment for each city:

- Annual debt service to fund future plant upgrades required to meet more stringent effluent limitations required at permit renewal. (Costs were estimated conservatively low by using a factor of $0.10 per gallon of plant capacity.)
- Annual debt service and O & M costs for known plant improvements that are required (i.e., UV disinfection facilities required at Portland and Aransas Pass).

The costs were tabulated in an annual cash flow format through the year 2020 for each city.[1]

Estimates were made of costs for 2.5 and 5.0 mgd primary and secondary wastewater treatment plants (WWTP). Capital and annual costs for a 2.5 mgd primary WWTP are $1.63 million and $312 thousand, respectively, with capital and annual costs for a 2.5 mgd secondary treatment plant of $4.88 million and $663 thousand, respectively. Capital costs for a 5.0 mgd primary treatment plant are $2.57 million, with annual costs of $488,000. Capital costs for a 5.0 mgd secondary treatment plant are $7.52 million, with annual costs of $1.02 million.

Annual benefits to individual Northshore area cities to participate in a regional wastewater collection and treatment facility, with sales of reclaimed water to Reynolds Metals for reuse includes cost savings from upgrading and operating existing facilities plus the proceeds from the

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[1]Cost estimates are for conveyance of wastewater to a regional wastewater treatment plant and for operation of a wastewater treatment plant which would be located adjacent to Reynolds Metals Company property, and do not include costs that Reynolds Metals must incur in order to be able to accept and use the wastewater at the Reynolds Metals manufacturing plant.

sale of reclaimed water. The costs include debt service and operation and maintenance of facilities (pumps, pump stations, and force mains) to move raw sewage to the regional treatment facility and a proportionate share of the debt service and operation and maintenance costs of the regional wastewater treatment plant. The benefits vary with price received for reclaimed water and costs of upgrading existing facilities. The costs vary with interest rates on capital required for both plant upgrade and new facilities and with distance that raw sewage must be transported. A benefit-cost analysis is presented for interest rates of 5, 6, 7, and 8 percent, assuming a reclaimed water price of $0.40 per thousand gallons (Tables ES-2 and ES-3).

The analysis showed that a regional wastewater collection, treatment, and reuse facility may be feasible for Portland, Gregory, Aransas Pass and Ingleside if interest rates on capital do not exceed 6 percent. Under the assumptions expressed above, the benefit-cost ratio for a Portland, Gregory, Aransas Pass, and Ingleside facility would be greater than 1.0 for each of the cities if interest on capital is 6 percent or less (Table ES-3). For a Portland, Gregory, Aransas Pass, and Ingleside facility, the quantity of effluent that could be supplied to Reynolds Metals for reuse would be 2.89 mgd or 3,237 acre-feet per year, which is slightly more than the 2.8 mgd of untreated water that was used by Reynolds Metals in 1992 and 1993. However, at the $0.40/1,000 gallons effluent price, if interest rates are 7 percent, the benefit-cost ratio for Ingleside drops below 1.0 and for Aransas Pass drops to a range of 0.9 to 1.1 (Table ES-3).

In the cases of Taft, Sinton, and Odem, the costs exceeded the benefits, due largely to the greater costs for conveyance of raw sewage for longer distances. Thus, this study shows that a regional wastewater reuse facility with Portland, Gregory, Aransas Pass, Ingleside, and Reynolds Metal Company may be feasible if interest rates are in the 5 to 6 percent range. The size of the regional wastewater treatment plant would need to be 5.0 mgd. It was determined

TABLE ES-2
REGIONAL WASTEWATER PRIMARY TREATMENT FACILITIES BENEFIT - COST RATIO

City Or Combination of Cities	Annual Benefit (In Thousands of Dollars)				Annual Cost (In Thousands of Dollars)					Benefit Cost Ratio
	Value of Effluent at $0.40 per 1,000	Cost Savings		Total Benefit	New Pump Station & Force Main		Regional WWTP		Total Cost	
		Plant Upgrade/ Maint.	Existing Plant O & M		Debt Service 8% Interest	O & M	Debt Service 8% Interest	O & M		
Portland	$183	$103	$269	$555	$153-187	$119	$149-183	$146	$567-635	0.9-1.0
Portland (Combined with Gregory)	$183	$103	$269	$555	$153-187	$119	$115-141	$112	$499-559	1.0-1.1
Gregory (Combined with Portland)	$35	$9	$102	$146	$50-61	$48	$34-42	$34	$166-185	0.8-0.9
Portland (combined with Aransas Pass	$183	$103	$269	$555	$153-187	$119	$119-145	$100	$491-551	1.0-1.1
Aransas Pass (combined with Portland)	$136	$152	$269	$557	$260-318	$236	$104-128	$88	$688-770	0.7-0.8
Portland (Combined with Gregory, Aransas Pass & Ingleside)	$183	$103	$269	$555	$153-187	$119	$90-110	$86	$448-502	1.1-1.2
Gregory (combined with Portland, Aransas Pass & Ingleside)	$35	$9	$102	$146	$50-61	$48	$26-32	$25	$149-166	0.9-1.0
Aransas Pass (Combined with Portland, Gregory & Ingleside)	$136	$152	$269	$557	$245-299	$202	$66-80	$63	$576-644	0.9-1.0
Ingleside (Combined with Portland, Gregory & Aransas Pass)	$69	$18	$191	$278	$115-141	$99	$54-66	$52	$320-358	0.8-0.9
Total of Portland & Gregory Combined	$218	$112	$371	$701	$203-248	$167	$149-183	$146	$665-744	0.9-1.1
Total of Portland & Aransas Pass combined	$319	$255	$538	$1112	$413-505	$355	$223-273	$188	$1179-1321	0.8-0.9
Total of Portland, Gregory, Aransas Pass & Ingleside Combined[1]	$423	$282	$831	$1536	$563-688	$468	$236-288	$226	$1493-1670	0.9-1.0

[1]Total quantity is 2.89 mgd or 3,237 acre-feet per year.

TABLE ES-3
REGIONAL WASTEWATER FACILITIES -- PRIMARY TREATMENT
COST SENSITIVITY ANALYSIS WITH VARYING INTEREST RATES

(In thousands of dollars)

City	Total Benefit	Total Cost (Debt Service & O & M)			Benefit - Cost Ratio		
		@ 7%	@ 6%	@ 5%	@ 7%	@ 6%	@ 5%
Portland	$555	$522-584	$488-546	$448-502	1.0	1.0-1.1	1.1-1.2
Portland (combined with Gregory)	$555	$459-514	$429-481	$394-442	1.1-1.2	1.2-1.3	1.3-1.4
Gregory (combined with Portland)	$146	$153-170	$143-159	$131-146	0.9-1.0	0.9-1.0	1.0-1.1
Portland (combined with Aransas Pass)	$555	$452-507	$422-474	$388-435	1.1-1.2	1.2-1.3	1.3-1.4
Aransas Pass (combined with Portland)	$557	$633-708	$592-662	$544-608	0.8-0.9	0.8-0.9	0.9-1.0
Portland (combined with Gregory, Aransas Pass & Ingleside)	$555	$412-462	$385-432	$354-397	1.2-1.3	1.3-1.4	1.4-1.6
Gregory (combined with Portland, Aransas Pass & Ingleside)	$146	$137-153	$128-143	$118-131	1.0-1.1	1.0-1.1	1.1-1.2
Aransas Pass (combined with Portland, Gregory & Ingleside)	$557	$530-592	$495-554	$455-509	0.9-1.1	1.0-1.1	1.1-1.2
Ingleside (combined with Portland, Gregory & Aransas Pass)	$278	$294-329	$275-308	$253-283	0.8-0.9	0.9-1.0	1.0-1.1
Total of Portland & Gregory combined	$701	$612-684	$572-640	$525-588	1.0-1.1	1.1-1.2	1.2-1.3
Total of Portland & Aransas Pass combined	$1112	$1085-1215	$1014-1136	$931-1044	0.9-1.0	1.0-1.1	1.1-1.2
Total of Portland, Gregory, Aransas Pass & Ingleside combined	$1536	$1374-1536	$1284-1436	$1179-1319	1.0-1.1	1.1-1.2	1.2-1.3

that use of effluent from other area industries (Dupont and Oxychem) could not be considered without further study.

ES 6.0 GREEN LAKE OUTFALL SYSTEM IMPROVEMENTS FOR FLOOD PROTECTION

The proposed improvements to the Green Lake outfall system include: (1) Spillway modifications; (2) Channel enlargements; and (3) Hydraulic improvements to railroad and highway structures that cross the Green Lake Channel. The spillway modifications needed are to drop the existing spillway's concrete sill (and top of risers) from elevation 20.5 to elevation 18.0 feet-msl, remove much of the existing embankment and replace it with a concrete ogee spillway with a crest elevation of 19.0 feet msl. The ogee spillway would have a crest length of 75 feet and would require the construction of new concrete retaining walls and an access bridge. The proposed modifications to the Green Lake Dam and Spillway Structure will lower the 100-year pool in Green Lake from elevation 30.0 to 25.9 feet-msl. The estimated spillway reconstruction cost is approximately $1.0 million, with an annual debt service of $102,000.

The proposed Phase I channel improvements include excavation to lower and widen the existing overbank areas to elevation 18.0 feet-msl. A bottom width to elevation 18.0 that varies between approximately 175 ft to approximately 250 ft is proposed for the main portion of the channel. Maximum 4:1 side slopes are proposed in order to enhance the greenbelt area and provide for ease of maintenance. Proposed Phase I improvements for the upstream portion of the Green Lake Channel include excavation at a slope of 0.035 percent with a bottom width of 125 ft and 3:1 side slopes. A stabilized roadbed that parallels the channel is also recommended in Phase I to allow ease of access for routine maintenance and future Phase II improvements.

The access road can be incorporated into the greenbelt design in order to provide maintenance of drainage and park facilities. It is anticipated that the majority of Phase I construction will be performed by the San Patricio County Drainage District (SPCDD). Cost of the Phase I channel improvements is estimated at $1.26 million for construction, with annual debt service of $129,000.

Construction costs for improvements to railroad and highway structures that cross the Green Lake channel are estimated at $2.23 million. By implementation of the Phase I improvements (spillway modifications, channel enlargement and alignments, and railroad and highway crossings), the existing 100-year water surface elevation in Gregory would be lowered by 1.9 feet, from approximately 33.1 feet-msl to approximately 31.2 feet-msl and would allow the channel to contain the 5-year flood.

Proposed Phase II improvements include excavating the main and upstream portions of the Green Lake Channel at a slope of 0.035 percent with a bottom width of 125 ft. and 3:1 side slopes. Further development of the greenbelt area may be implemented during Phase II, as funds are available.

Phase II improvements could lower the calculated water surface elevation (CWSEL) in southwestern Gregory by approximately 1.9 ft., from the Phase I CWSEL at approximately 31.2 ft to the Phase II CWSEL of approximately 29.3 ft. In comparison to existing conditions, Phase I and II improvements could reduce the CWSEL a total of 3.8 feet from the estimated existing conditions CWSEL of 33.1 feet-msl. A comparison of the computed water surface profiles for each of the conditions shows that Phase II improvements reduce the CWSEL for all flood frequencies analyzed (5, 10, 25, 50, and 100-year). The 5 and 10-year floods would be contained within the channel banks, however, the 100-year flood target water surface elevation of 28.0 feet-msl would not be completely contained within the ultimate Phase II channel improvements.

Phase II construction costs are estimated at $353,000, with an annual debt service of $36,000. These cost estimates are based on the assumption that excavation would be performed by the SPCDD, with spreading of disposal materials to adjacent land.

Estimated annual costs for Green Lake Channel and spillway improvements to protect against the 100-year flood event are $529,000 and would produce annual benefits estimated at $413,000 plus non-pecuniary water quality enhancements and recreational and ecological benefits. Although the benefit-cost ratio for the 100-year event is 0.8, the improvements considered would fully protect the area in the case of the five and 10-year flood events.

ES 7.0 EFFECTS OF WASTEWATER REUSE UPON THE YIELD OF THE CHOKE CANYON/LAKE CORPUS CHRISTI SYSTEM

If raw water now being used by industry were replaced with municipal wastewater effluent, then present demands upon the CC/LCC System would be reduced by the quantity of municipal wastewater effluent that is substituted for raw water from the system. However, since some of the municipal wastewater effluent being considered for industrial use is now being discharged to Nueces Bay and is included in the quantities specified by the TNRCC interim order, it is necessary to evaluate the effects upon yields of the CC/LCC System of shifting wastewater discharges from Nueces Bay to industrial users. Since under the interim TNRCC order, CC/LCC releases to Nueces Bay would have to be increased to offset the credit being obtained from the wastewater effluent that would be shifted from the bay to industrial use, water available for other purposes would likely be decreased somewhat. These CC/LCC yield effects were calculated using a simulation model of the Lower Nueces River Basin and Estuary, including the CC/LCC System. Computations in the model simulate evaporation losses from the reservoirs as well as channel losses in the delivery of water from Choke Canyon Reservoir (CCR) to Lake Corpus Christi (LCC), and from LCC to Calallen diversion dam. In addition, the model computes the firm yield of the reservoir system given the operating policy and other institutional requirements imposed on the system. Under the City of Corpus Christi's present operating policies for the CC/LCC System, the effect of diverting Portland's projected year 2000 quantity of wastewater (1.25 mgd or 1,400 acre-feet per year) to industrial reuse would increase the water supply available from the CC/LCC System by 612 acre-feet per year.

For example, the use of 1,400 acre-feet of wastewater effluent by industry reduces the demand upon the CC/LCC System by 1,400 acre-feet. However, the reduction of wastewater discharges to Nueces Bay of 1.25 mgd (1,400 acre-feet) per year requires additional releases from the CC/LCC System which reduces the system yield by 788 acre-feet, resulting in a net increase of 612 acre-feet per year upon the area's water supply.

ES 8.0 COST OF WASTEWATER REUSE IN COMPARISON TO COSTS OF OTHER SOURCES OF ADDITIONAL WATER SUPPLY

In view of the need for additional water supplies for the CC/LCC Service area, studies are in progress to identify and calculate the costs of additional water supplies for the area, including wastewater reuse. As estimated in this study, the potential annual quantity of wastewater reuse in year 2000 is about 3,200 acre-feet in the Northshore area at an estimated cost of $461 per acre-foot (1993 prices). (Note: The wastewater is already at the point of use, while other supplies mentioned below are at Calallen, for which 28 miles of pumping costs must be incurred.) This quantity and price compares favorably to other alternatives being considered which range in size from approximately 30,000 acre-feet per year at costs of $300 per acre-foot delivered to Calallen from Lake Texana near Edna, Texas, to pipelines from Choke Canyon to Lake Corpus Christi that would yield 18,000 acre-feet per year at $614 per acre-foot delivered to Calallen.

Desalting seawater would cost more than $1,400 per acre-foot, while a Nueces Delta wastewater reuse project would increase yield by 16,500 acre-feet per year at an estimated cost of $56 per acre-foot at Calallen.

ES 9.0 INSTITUTIONAL AND ORGANIZATIONAL CONCEPTS FOR A REGIONAL WASTEWATER REUSE ENTITY

A special district to own and operate a regional wastewater collection, treatment, and reuse system will need the following powers:

- The power to have NPDES and state permits to receive wastewater from the cities, to treat the wastewater, and to transport the effluent by pipeline to Reynolds.
- The power to finance, construct, operate and maintain all facilities needed to exercise its purposes.
- The power to charge rates, or to receive payments from other sources, so as to finance its operations. Consideration must be given to whether the district will have the power to assess, level and collect taxes.
- The power to obtain, by eminent domain, or otherwise, sufficient land and all necessary easements, rights-of-way and leases for its facilities.

The San Patricio Municipal Water District has the necessary powers, as authorized by "The Regional Waste Disposal Act," which authorizes districts to perform the functions contemplated in this study. It authorizes the SPMWD to contract with the cities to perform these functions, and the cities are authorized to pay for service from their waterworks system, sewer system, or their combined water and sewer system revenues. The SPMWD may issue bonds secured by a pledge of all or part of the revenue from these contracts. However, legal questions listed below will need to be considered further when implementation of a regional wastewater reuse project is considered. The questions are:

- Will the SPMWD be required to obtain NPDES and state permits?
- Will the plant be a publicly owned treatment system?
- Will anyone that has come to rely on the cities' discharge for their withdrawal of water from streams complain?
- Who holds the dam and reservoir permit for Green Lake? Will this permit have to be amended?
- Will the bonds of the SPMWD be tax exempt if Reynolds Metals has an absolute obligation to take the effluent for a long period of years?

Answers to the questions listed above will determine what has to be done to resolve the issues and allow implementation of a project.

ES 10.0 RECOMMENDED PLAN

Based upon the analyses of this study, the following actions are recommended for further consideration:

1) A regional wastewater collection, treatment, and reuse system, which includes the Cities of Portland, Gregory, Aransas Pass, and Ingleside, with delivery of wastewater to Reynolds Metals for reuse; this project would increase water supply to the San Patricio Municipal Water District service area by about 3,237 acre-feet per year or 23 percent of the present level of water use from the SPMWD system;

2) An interim plan in which the City of Portland's effluent from its existing wastewater treatment plant be conveyed to Reynolds Metals for reuse, as soon as possible, with Portland being phased into the regional system as soon as possible; this effect would increase the San Patricio Municipal Water District service area water supply by about

1,400 acre-feet per year or about 10 percent in year 2000;

3) Green Lake Outfall System Improvements as follows:

   a) Spillway modifications that drop the concrete sill to 18.0 feet msl, remove embankment and replace with run-of-river concrete ogee spillway with crest elevation of 19.0 feet msl, crest length of 75 feet, new concrete retaining walls, and an access bridge;

   b) Phase I channel excavation to lower and widen existing overbank areas of the main channel, downstream reaches, to elevation 18.0 feet msl, with a bottom width that varies between 175 feet and 250 feet for the main channel. Side slopes should be 4:1.

   c) Hydraulic improvements to railroad and highway improvements; and

   d) Phase II excavation of upstream portions of the Green Lake Channel at a slope of 0.035 percent with a bottom width of 125 feet and 3:1 side slopes.

4) Establish a new rate schedule wherein NSCC would become a direct industrial customer of the SPMWD for purchase of irrigation water.

NORTHSHORE REGIONAL WASTEWATER REUSE, WATER SUPPLY, AND FLOOD CONTROL PLANNING STUDY -- SAN PATRICIO COUNTY, TEXAS

1.0 INTRODUCTION

1.1 Background

San Patricio County is located to the north of Nueces and Corpus Christi Bays and is a part of the Texas Coastal Bend area (Figure 1-1). In 1990, the population of the county was 58,749; the county is projected to have a population of 98,010 to 109,421 by 2040[2]. The economy of the county includes agriculture, agribusiness, petroleum production, fishing, petrochemicals, tourism and recreation. Water supply and flooding are continual problems for large areas of the county.

The 12-county Coastal Bend area of Texas depends upon the Choke Canyon/Lake Corpus Christi Reservoir System (CC/LCC System) for more than 80 percent of its municipal and industrial water. The area, which includes Corpus Christi and neighboring cities, including those of San Patricio County, had a population of 530,878 in 1990, and is projected to have more than one million inhabitants by 2040 (Figure 1-1). Industries that depend upon the CC/LCC System include approximately 14 percent of Texas petroleum refining capacity and 8.7 percent of Texas chemical production capacity.

Development and use of the CC/LCC System for municipal and industrial water is authorized by Texas Natural Resource Conservation Commission (TNRCC) (formerly Texas Water Commission (TWC)) Certificate of Adjudication No. 21-3214, held by the City of Corpus Christi, the Nueces River Authority, and the City of Three Rivers. The permit for the system

[2]Unpublished planning information, Texas Water Development Board, April, 1992, Austin, Texas.

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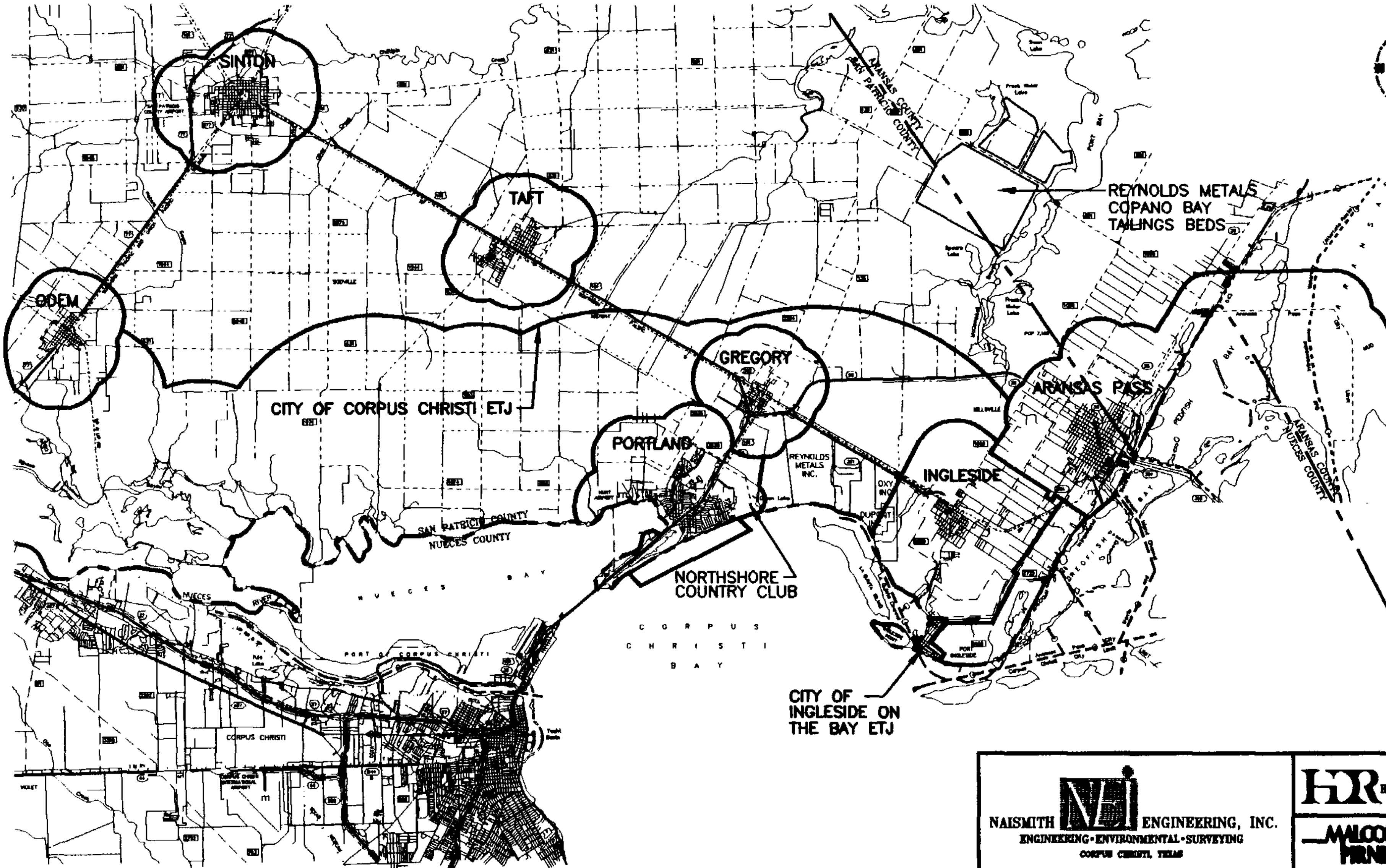
CHOKE CANYON/LAKE CORPUS CHRISTI
SERVICE AREA

FIGURE 1 - 1

Drawn By: A. NORIEGA	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-SA1	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

contains "special conditions" which state that the owners of the CC/LCC System should provide not less than 151,000 acre-feet of water per year to the receiving estuaries through a combination of treated wastewater return flows, reservoir spills, and reservoir releases. On March 9, 1992, the TWC ordered a monthly schedule of inflows in the amount of 151,000 acre-feet annually, such inflows to consist of return flows, intentional diversions, and spills and releases from the reservoir system. Among the provisions ordered are that the "certificate holders are to provide in any future contracts or any amendments, modifications or changes to existing contracts the condition that all wholesale customers and any subsequent wholesale customers shall develop and implement water conservation and drought contingency measures. Certificate holders shall comply with all applicable rules of the Commission dealing with water conservation. The City of Corpus Christi shall solicit from its customers and report to the Commission annually the result of conservation under the City's plan, the customers' plans, and the feasibility of implementing conservation plans and programs for all users of water from the reservoir system." The San Patricio Municipal Water District (SPMWD) is one of the wholesale customers to which these conditions apply.

Most of the northshore area of San Patricio County (Figure 1-2) depends upon the SPMWD for its municipal and industrial water supply. The SPMWD obtains both treated water and raw water from the CC/LCC System. The SPMWD currently has two ways by which to provide treated water. The first is through a 24-inch treated water line from the City of Corpus Christi O.N. Stevens water treatment plant. This 28-mile line was originally installed by the Reynolds Metals Company and later deeded to the City of Corpus Christi. The line was purchased by the SPMWD from the City in 1982. Water service is provided to the Cities of Odem, Taft, Gregory, and Portland through this line.



LEGEND

ETJ LINE

COUNTY LINE

GRAPHIC SCALE IN FEET

20000 10000 0 20000 40000

HORIZONTAL

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STUDY AREA LOCATION MAP

FIGURE 1 - 2

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Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:	of

The second way the SPMWD provides treated water is through the SPMWD's own treatment plant, which is located approximately three miles northwest of Ingleside on State Highway 361. This plant draws untreated water from a 12 million gallon ground storage reservoir (see following paragraph for further explanation) at the plant site and has a peak hydraulic capacity of approximately 10 mgd. Treatment capacity of the plant is approximately 9.0 mgd. The plant can also receive treated water directly from the SPMWD's 24-inch line. Present peak day production from this plant has ranged between 7.0 and 8.0 mgd.

Untreated water is taken directly from the Nueces River at the W.A. Edwards Nueces River Pump Station. It is then transported in a 36-inch, 28-mile transmission line to the Reynolds Metals Company's Red Mud Lake. From there the line is reduced to 30 inches and continues to a point just outside the SPMWD's treatment plant property. The line is then reduced to 24 inches and continues to the 12 million gallon ground storage reservoir. This line is also connected to the headworks of the treatment plant, and is valved to allow raw water to be pumped directly into the plant, bypassing the reservoir. A connection is also provided from the ground storage reservoir to the E.I. DuPont de Nemours plant to supply process water. The SPMWD's plant typically uses the reservoir as its primary source of supply.

It is important to note that demands upon the CC/LCC System are projected to exceed the supply available within eight to 10 years. In addition, it is equally important to note that the SPMWD's transmission system (water lines, pumps, and storage facilities) is presently operating at or near its 28 to 30 million gallons per day of capacity. Thus, the SPMWD is faced with a growing water demand and no way to meet either short-term or long-term needs without adding a new, 28-mile water line. (Note: with increased booster stations, a small percentage of additional capacity can be obtained, but at a very high and inefficient use of energy).

Drainage and flooding problems related to the Green Lake outfall structure and contributing channels have existed for many years. The drainage basin has 10.95 square miles of area upstream of the outfall structure at Green Lake. An inadequate primary outfall channel, combined with the inadequate structural and hydraulic capacity of the outfall structure contributes to frequent flooding of the area located between the cities of Gregory and Portland, including the southwestern portions of the City of Gregory.

The original dam structure was constructed in the 1940's to assist in eliminating severe erosion of the natural topography. The spillway elevation was constructed to an elevation of 22.36 feet-msl. During the 1970's and early 1980's, Northshore Development Corporation, located primarily on the western banks of Green Lake, secured a TWC Permit authorizing use of stored surface waters for irrigation of the newly constructed golf course and homesite development.

In 1983, the San Patricio Drainage SPMWD noticed severe leaks and downstream slope failures of the dam structure, and authorized a structural inspection of the dam. In 1984, representatives from the San Patricio County Drainage SPMWD, cities of Portland and Gregory, and representatives of Northshore Developers discussed needed repair work, and agreed at that time to lower the spillway elevation to 20.50 feet-msl. A San Patricio County flood control study in 1987 recommended two alternative solutions to the flooding and drainage related problems. One was to construct an off-channel emergency spillway structure to the east along the Reynolds Metals Company property line, leaving the Green Lake outfall structure at the elevation of 20.50 feet-msl. Cost of this alternative was approximately $1.7 million. In addition, approximately $3.1 million was needed in dam repairs and other channel improvements to the Green Lake system.

The alternative solution recommended lowering the dam structure to elevation 15.0 feet-msl. No emergency spillway structure would be required. Cost to perform this work was estimated at approximately $3.0 million. Although this alternative solution offered the most benefits and the lowest initial capital cost, the issue of water rights for the Northshore Development was not resolved, and, to date, no implementation has been carried out.

1.2 Objectives

The principal objectives of this study are to identify and evaluate the potential to collect wastewater from municipalities of the study area and convey such wastewater to industry (Reynolds Metals in particular) where such wastewater would be used to meet a part or all of the industry's freshwater needs that are now being met with supplies obtained through the SPMWD's system which depends upon the CC/LCC System. In addition, since a part of the City of Portland's wastewater is discharged into Green Lake, which is an integral part of the drainage and floodwater management system of San Patricio County, affecting the Cities and Extraterritorial Jurisdictions of Gregory and Portland, and industrial and agricultural areas of eastern San Patricio County, it is highly desirable to evaluate the potential for the development of flood management plans for the Green Lake outfall system and adjacent water courses which would reduce flood elevations and perhaps increase water supply for golf course irrigation in the Northshore area.

An evaluation was made of lowering the Green Lake outfall structure to a calculated level to reduce flooding frequency and at the same time utilize flows into Green Lake to satisfy irrigation needs. In this way, supplemental irrigation supplies from the drainage system could perhaps contribute to increasing the overall regional water supplies, reduce the demands upon the present system, and accomplish some of the water conservation requirements of the TWC's March 1992 freshwater release order for the CC/LCC System.

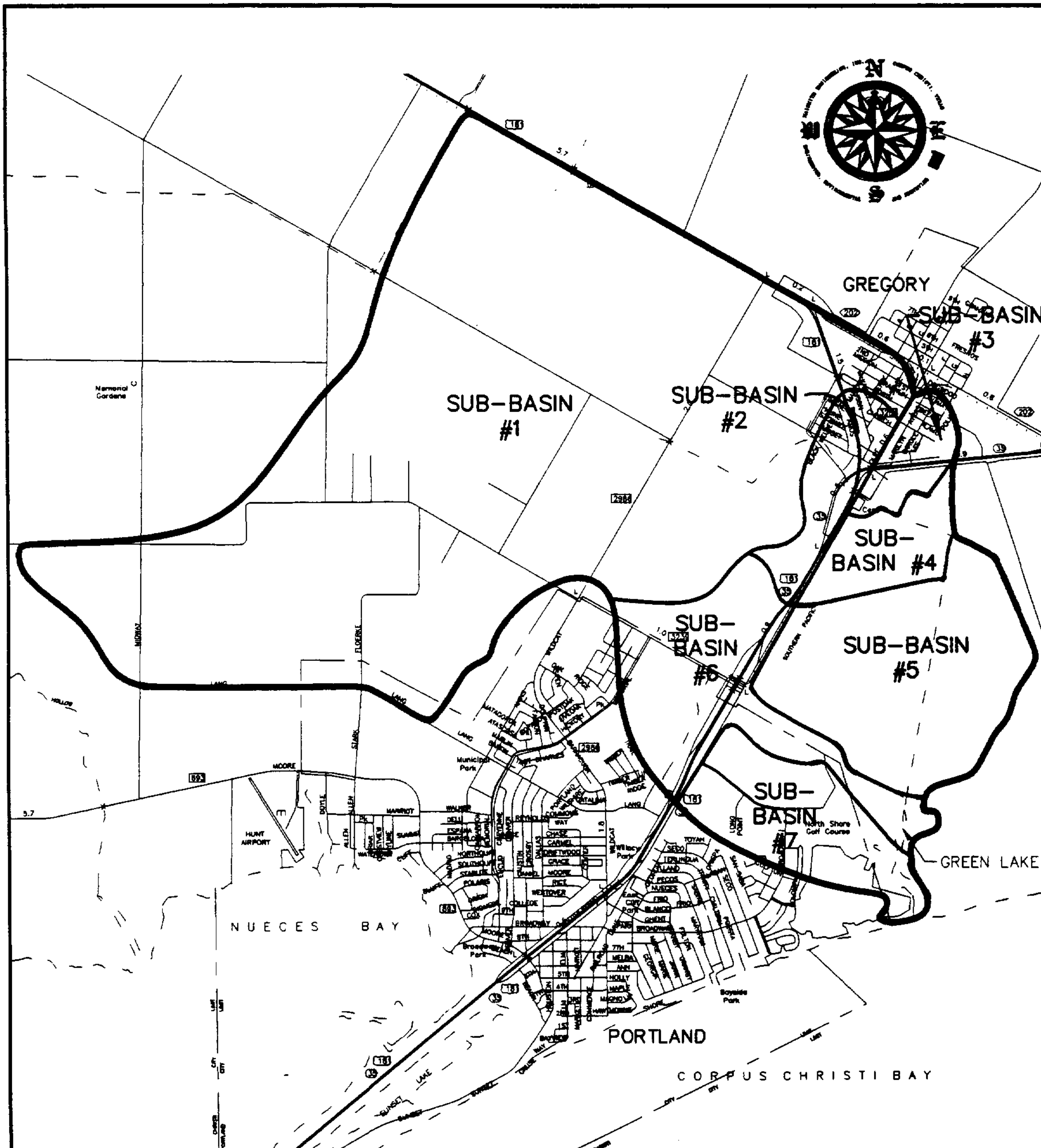
1.3 Study Area Description

The primary study area is located in southeast San Patricio County and includes portions of the City limits of Portland and the extraterritorial jurisdictions of the Cities of Portland, Gregory and Corpus Christi. Highway access to the area is provided by U.S. 181, which enters Gregory from the northwest and extends southwesterly through Portland; SH 361, extending southeasterly from Gregory to Ingleside; and SH 35, extending easterly from Gregory to Aransas Pass. The study area is bounded on the South by Corpus Christi Bay. Deep water port access is provided to the eastern portion of the Northshore area from Corpus Christi Channel via the La Quinta Channel and La Quinta Turning Basin. A significant industrial complex, including Reynolds Metals Company (Reynolds), E. I. DuPont De Nemours & Co. (DuPont) and Occidental Chemical Corporation (Oxychem), maintains access to this port facility. In addition, rail service is provided by the Southern Pacific tracks, which run parallel to U.S. 181 and SH 361.

The cities of the study area also include Ingleside, Ingleside on the Bay, Aransas Pass, Taft, Sinton, and Odem (Figure 1-2).

The terrain in the area is primarily flat to slightly sloping (0 to 1 percent sloping generally from the west-northwest to the east-southeast). Open land outside the developed urban and industrial areas is used mostly for agriculture (crop production and grazing).

Drainage for the major portion of the area (approximately 11 square miles) flows into Green Lake and its tributary channels (Figure 1-3). Approximately 70 percent of the watershed



GRAPHIC SCALE IN FEET

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GREEN LAKE DRAINAGE BASIN MAP

FIGURE 1 - 3

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Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:

concentrates upstream of the U.S. 181 and Southern Pacific Railroad crossings of the Green Lake Channel immediately south of Gregory.

Soils consist primarily of sandy clay loam (Orelia series), clay loam (Raymondville series) and clay (Victoria series). Soils are very slowly permeable to slowly permeable and generally have a high shrink-swell potential (Ref. 6). The subsurface water table is relatively shallow and is moderately saline to strongly saline.

Aerial photogrammetric mapping showing one foot contour intervals at a scale of one inch to 100 feet was funded by the San Patricio County Drainage District. Photographs utilized for the preparation of these maps were taken in January through March, 1993, and provided current topographic and planimetric information for the study analysis.

2.0 POTENTIAL FOR REGIONAL WASTEWATER EFFLUENT REUSE AND REGIONAL WASTEWATER TREATMENT

The objectives of this section of the report are to:

- Identify and evaluate alternatives for meeting a portion of the area's municipal and industrial freshwater needs through a regional effluent reuse system, and

- Evaluate the feasibility of a regional wastewater collection and treatment system.

2.1 Municipal and Industrial Wastewater Effluent

2.1.1 Existing Major Municipal Wastewater Collection and Treatment Infrastructure

Locations of existing municipal WWTP's in the study area are shown in Figure 2-1.

2.1.1.1 Aransas Pass

2.1.1.1.1 Collection System

The City's collection system consists of fifteen (15) lift stations and collection lines ranging from 6-inches to 24-inches in diameter. Sub-areas of the system connect into 24-inch and 12-inch gravity sewers that flow into the Ransom Island Lift Station located along Ransom Drive approximately 1,200 feet west of the wastewater treatment plant. Raw wastewater is then pumped in a 12-inch force main to the WWTP (Figure 2-2).

2.1.1.1.2 Treatment Plant

The City's treatment plant consists of an activated sludge extended aeration system in oxidation ditches, followed by clarification and chlorination prior to discharge of the effluent directly into Redfish Bay. The plant discharges under the following permits:

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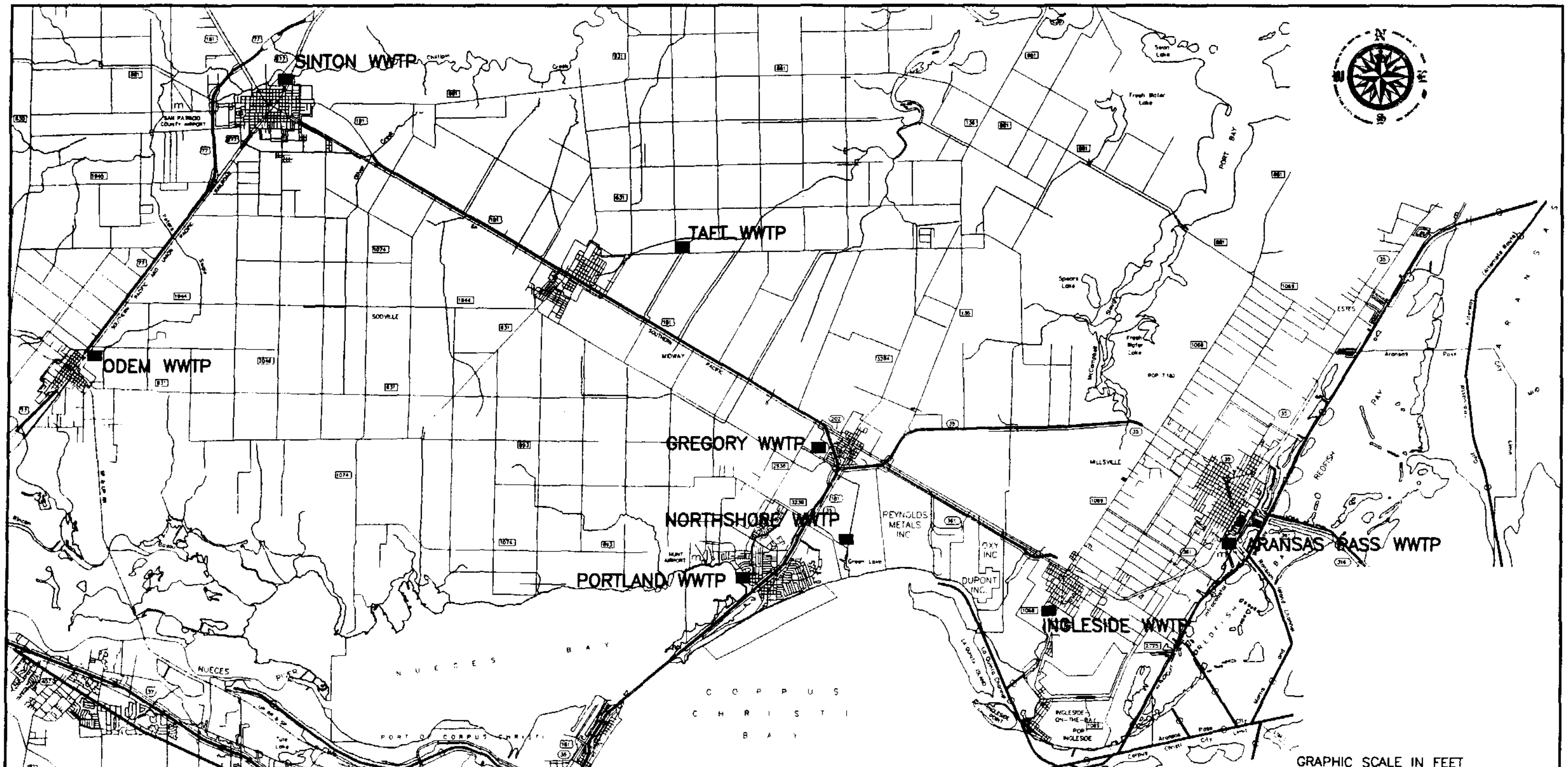

GRAPHIC SCALE IN FEET

12000 6000 0 12000 24000

HORIZONTAL

EXISTING WASTEWATER TREATMENT PLANTS

CITY	PERMITTED CAPACITY (M.G.D.)	ACTUAL 1992 ADF (M.G.D.)	PROJECTED 2020 ADF (M.G.D.)*	CURRENT EFFLUENT LIMITATIONS	PERMIT STATUS
ARANSAS PASS	1.8	0.846	1.22	20 BOD/20 TSS	RENEWAL IN PROGRESS
GREGORY	0.32	0.236	0.48	20 BOD/20 TSS (10 BOD/15 TSS/3 AMMONIA NITROGEN REQUIRED BY MARCH 1, 1995)	EXPIRES APRIL 17, 1997
INGLESIDE	2.0	0.467	1.04	10 BOD/15 TSS/ 3 AMMONIA NITROGEN	EXPIRES MARCH 20, 1995
ODEM	0.273	0.128	0.32	30 BOD/90 TSS	EXPIRES JUNE 27, 1996
PORTLAND MAIN	2.5	1.135	1.86	20 BOD/20 TSS	EXPIRES MARCH 21, 1997
PORTLAND NORTHSHORE	0.2	0.042	–	20 BOD/20 TSS (10 BOD/15 TSS REQUIRED BY NOVEMBER 1, 1994	EXPIRES OCT. 31, 1998
SINTON	0.8	0.517	0.82	30 BOD/90 TSS	
TAFT	0.9	0.507	0.67	10 BOD/15 TSS/ 3 AMMONIA NITROGEN	EXPIRES FEB. 28, 1996

* ARANSAS PASS BASED ON ACTUAL FLOW OF 115 GALLONS PER CAPITA PER DAY (GPCD). ALL OTHER CITIES BASED ON RECOMMENDED PLANNING VALUE OF 100 GPCD.

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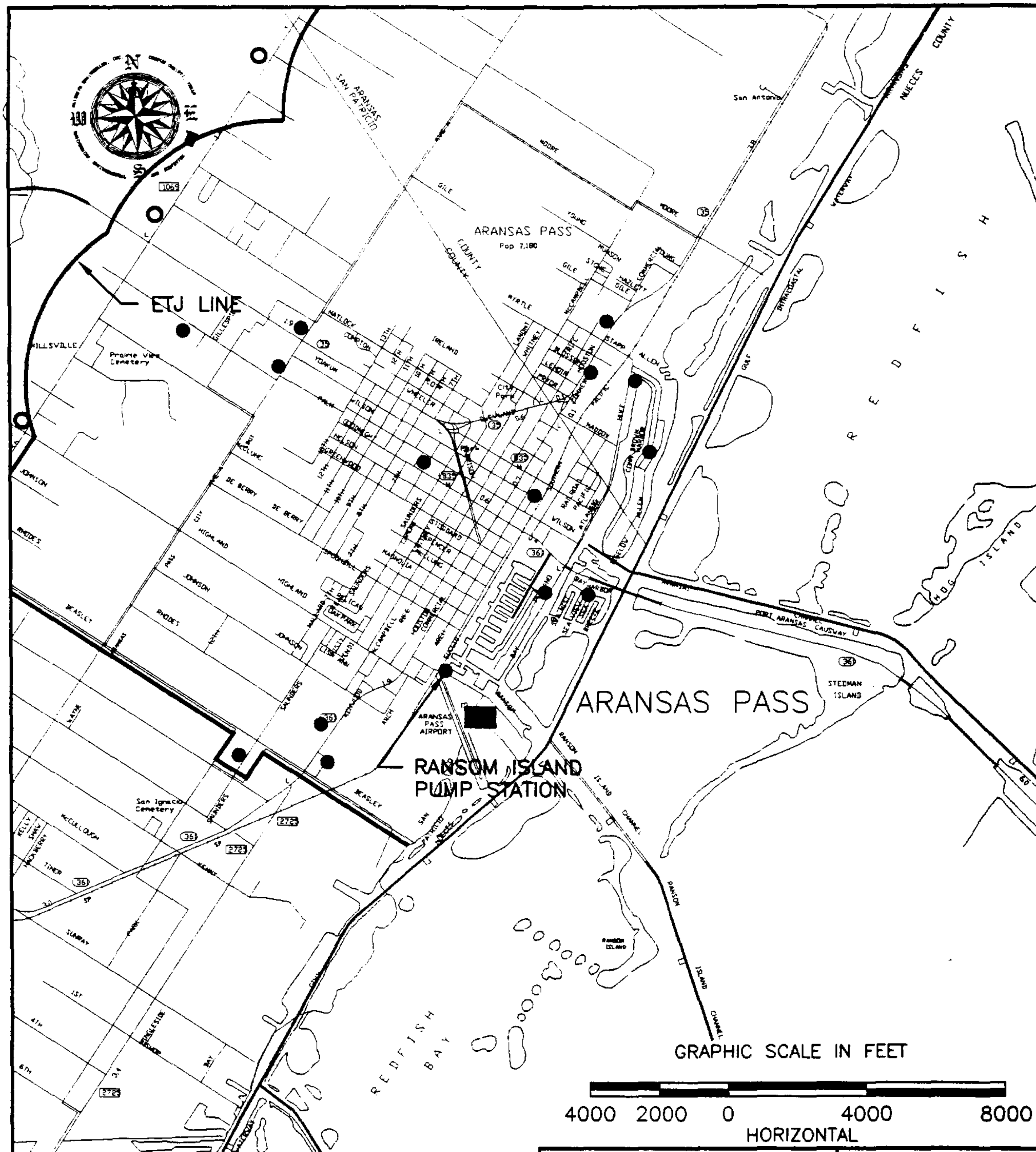
WASTEWATER TREATMENT PLANT LOCATION MAP

FIGURE 2 - 1

E. BUSSEY	G. BRIDGES	AS NOTED	3745-WW1	1
G. BRIDGES	3745	3/94	0	1



LEGEND

- ● EXISTING WW LIFT STATION
- ○ FUTURE WW LIFT STATION (AS PER LIVE OAK RIDGE REGIONAL MASTER PLAN)
- ■ EXISTING WWTP

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ARANSAS PASS WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 2

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Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:

EPA NPDES Wastewater Permit No. TX0025682
Renewed: March 22, 1992
Expires: March 21, 1997
TNRCC Permit No. 10521-02
Expired February 16, 1993
Currently in process of being renewed and amended.

Permit limitations are as follows:

Effluent Characteristic	Discharge Limitations
Average flow	1.6 mgd
2-hour peak flow	3.1 mgd
BOD_5	20 mg/L
TSS	20 mg/L

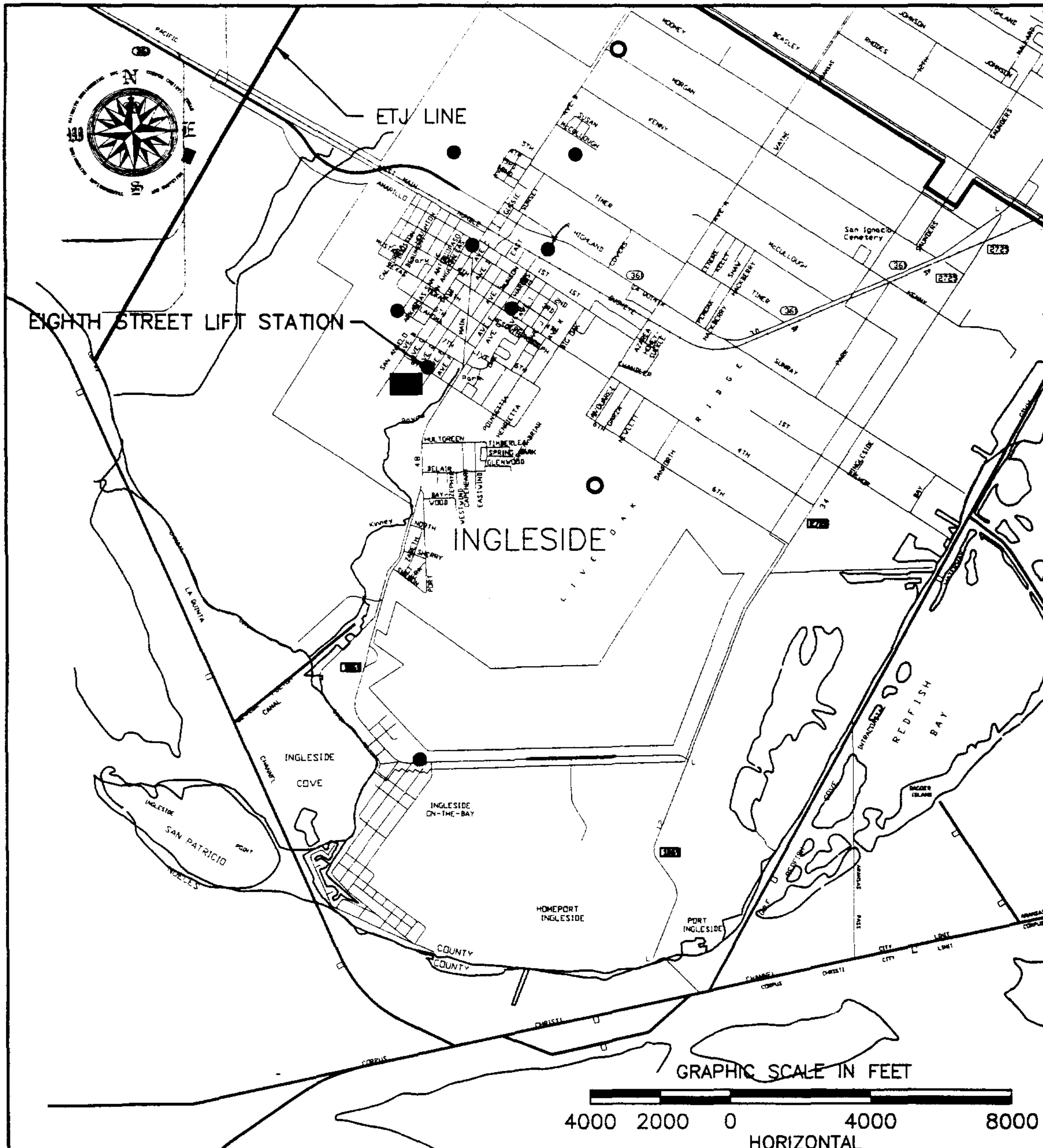
2.1.1.2 Ingleside

2.1.1.2.1 Collection System

Ingleside's collection system consists of eight lift stations and collection lines ranging from 6-inches to 24-inches in diameter. In addition to providing collection of municipal wastewater from the City, the system receives wastewater flow from the U.S. Navy's Homeport Facility (Homeport). A system of force mains, lift stations and gravity trunk lines extend from Homeport to collection lines that flow to the City's WWTP. All raw wastewater flows to the Eighth Street Lift Station located at the plant site (Figure 2-3).

2.1.1.2.2 Treatment Plant

The City's treatment facility consists of two separate 1 mgd plants. The original 1 mgd plant was placed into service in 1985. The plant uses a complete mix activated sludge process followed by clarification, chlorination, dechlorination and discharge of effluent directly to Kinney Bayou.



LEGEND

●	EXISTING WW LIFT STATION
○	FUTURE WW LIFT STATION (AS PER LIVE OAK RIDGE REGIONAL MASTER PLAN)
■	EXISTING WWTP

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INGLESIDE WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 3

Drawn By E. BUSSEY	Appr. By G. BRIDGES	Scale AS NOTED	Dwg. No. 3745-S14	Sheet
Checked By G. BRIDGES	Project No. 3745	Date 3/94	Rev.	of

The newest 1 mgd plant is an extended aeration system in oxidation ditch, followed by clarification, chlorination, dechlorination and discharge of effluent directly to Kinney Bayou.

Currently, the City is operating the original 1 mgd plant and has temporarily taken the oxidation ditch plant out of service. The plant discharges under the following permits:

EPA NPDES Wastewater Permit No. TX0020401
Renewal: March 20, 1990
Expires: March 20, 1995
TNRCC Permit No.: WQ0010422-001

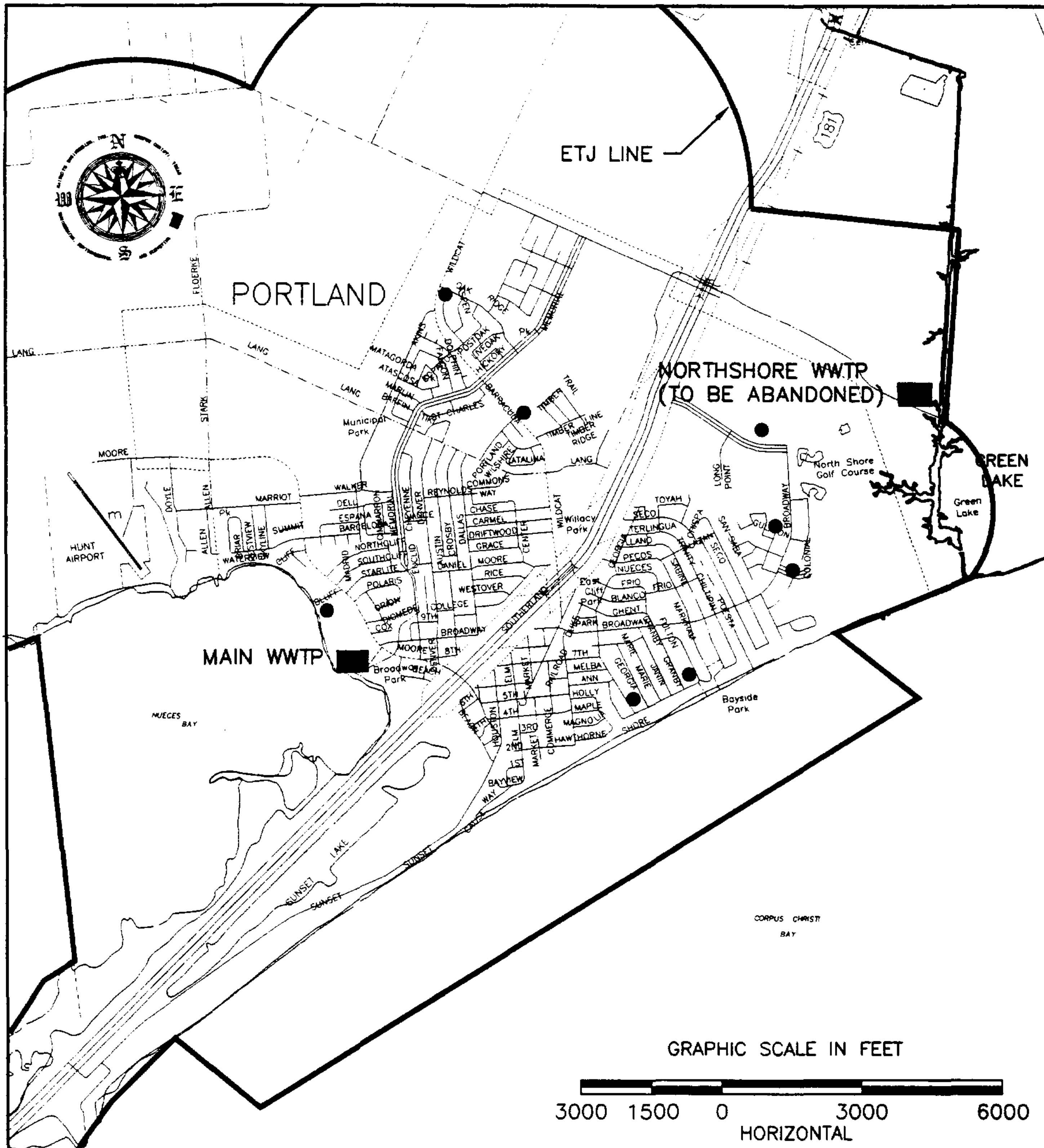
Permit Limitations are as follows:

Effluent Characteristics	Discharge Limitation
Average flow	2.0 mgd
2-hour peak flow	Not Applicable
BOD_5	10 mg/L
TSS	15 mg/L
Ammonia-Nitrogen	3 mg/L
Dissolved Oxygen (minimum)	4 mg/L

2.1.1.3 Portland

2.1.1.3.1 Collection System

Portland's wastewater collection system consists of eight lift stations and collection lines ranging from 6-inches to 24-inches in diameter. The system is currently divided into two service areas, one for the City's Main Plant and one for the Northshore Plant. Sub-areas of the Main Plant's service area combine into a 24-inch gravity trunk sewer, at West Broadway Avenue and Moore Avenue, that flows into the plant. The system serving the Northshore Plant flows into a lift station on East Broadway Avenue near Long Point Drive, and raw wastewater is pumped to the plant in a 12-inch force main (Figure 2-4).



LEGEND

- ● EXISTING WW LIFT STATION
- ■ EXISTING WWTP

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PORTLAND WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 4

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.: 3745-S09
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:

The City is currently in the process of making improvements to the collection system which will allow abandonment of the Northshore Plant, with diversion of its raw wastewater to the Main Plant for treatment. The force main from the lift station on East Broadway Avenue will be extended westerly to US 181, then southwesterly parallel to US 181 to the gravity trunk sewer in West Broadway that flows into the Main Plant. Construction of this rerouting project is scheduled for completion by the end of 1994.

2.1.1.3.2 Treatment Plant

The Main Plant uses the contact stabilization modification of the activated sludge process and includes grit removal, contact basin, clarifier, reaeration basin, aerobic sludge digester, sludge thickener and sludge drying beds. The effluent is disinfected by an aerated chlorine contact chamber and discharged directly into Nueces Bay. The Main Plant discharges under the following permits:

EPA NPDES Wastewater Permit No. TX0055433
Issued: March 22, 1992
Expires: March, 21, 1997
TNRCC Permit No. 10478-01
Issued: March 25, 1994
Expires: March 25, 1999

Permit limitations are as follows:

Effluent Characteristics	Discharge Limitations	
	Interim	Final (beginning 1/1/97)
Average flow	2.5 mgd	2.5 mgd
2-hour peak flow	5208 gpm	5208 gpm
BOD_5	20 mg/L	20 mg/L
TSS	20 mg/L	20 mg/L
Dissolved Oxygen (min.)	2 mg/L	5 mg/L
Declarination	Required	Required

The Northshore Plant uses the extended air activated sludge process, followed by clarification and chlorination prior to discharge of effluent directly into the Green Lake drainage channel, thence to Corpus Christi Bay in Segment No. 2481 of the San Antonio-Nueces Coastal Basin. The plant discharges under the following permits:

EPA NPDES Wastewater Permit No. TX0089095
Issued: March 7, 1992
Expires: March 6, 1997
TNRCC Permit No. 10478-02
Renewed: October 31, 1991
Expires: October 31, 1996

Permit limitations are as follows:

Effluent Characteristics	Discharge Limitations
Interim (through October 31, 1994)	
Average flow	0.200 mgd
2-hour peak flow	400 gpm
BOD_5	20 mg/L
TSS	20 mg/L
Dissolved Oxygen (minimum)	2.0 mg/L
Final (beginning November 1, 1994)	
Average flow	0.200 mgd
2-hour peak flow	400 gpm
BOD_5	10 mg/L
TSS	15 mg/L
Dissolved Oxygen (minimum)	4.0 mg/L

As previously mentioned, the City plans to abandon the Northshore plant and reroute its raw wastewater to the Main Plant for treatment by November 1, 1994.

2.1.1.4 Sinton

2.1.1.4.1 Collection System

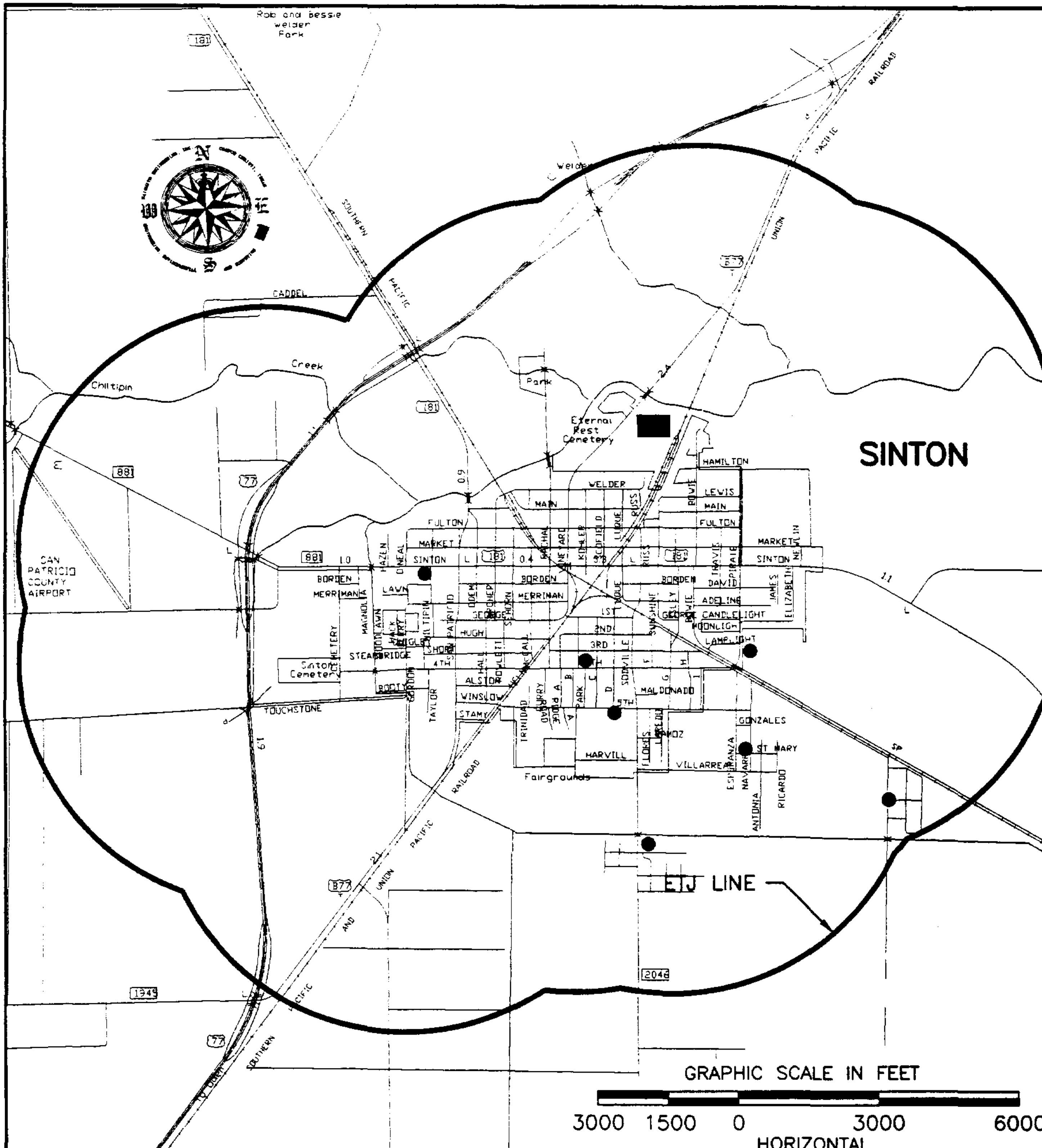
Sinton's collection system consists of four lift stations and collection lines ranging from 6-inches to 15-inches in diameter. Three additional lift stations are currently under construction, along with gravity collection lines, to serve the Rancho Chico, Buena Vista and Dodd Subdivisions, which will become part of the City's system. Sub-areas of the system are connected into a 15-inch gravity trunk sewer in Welder Street east of U.S. 77. The trunk sewer extends northward at the intersection of North Luque Street and Welder Street to the treatment plant on the south side of Chiltipin Creek and east of U.S. 77 (Figure 2-5).

2.1.1.4.2 Treatment Plant

The City's treatment plant consists of sedimentation/digestion in a combination clarigester, followed by biological treatment using two trickling filters (one high rate followed by one standard rate filter). Flow is then to a 3.3 acre facultative lagoon and two sedimentation ponds, totaling 7.17 acres of surface area. The lagoon system, which was constructed in 1983, provides approximately 34 days of detention time. Chlorination is not required prior to discharge. Effluent is discharged into Chiltipin Creek, thence to the Aransas River in Segment No. 2003 of the San Antonio-Nueces Coastal Basin. The plant discharges under the following permits:

EPA NPDES Wastewater Permit No. TX0024562
Renewal: Administrative approval granted on November 4, 1993
TNRCC Permit No. 10055-01

Permit limitations are as follows:



LEGEND

- ● EXISTING WW LIFT STATION
- ■ EXISTING WWTP

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SINTON WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 5

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.: 3745-S10	Sheet:
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

Effluent Characteristics	Discharge Limitations
Average flow	0.8 mgd
2-hour peak flow	N/A
BOD_5	30 mg/L
TSS	90 mg/L
Dissolved Oxygen (minimum)	4.0 mg/L

2.1.1.5 Gregory

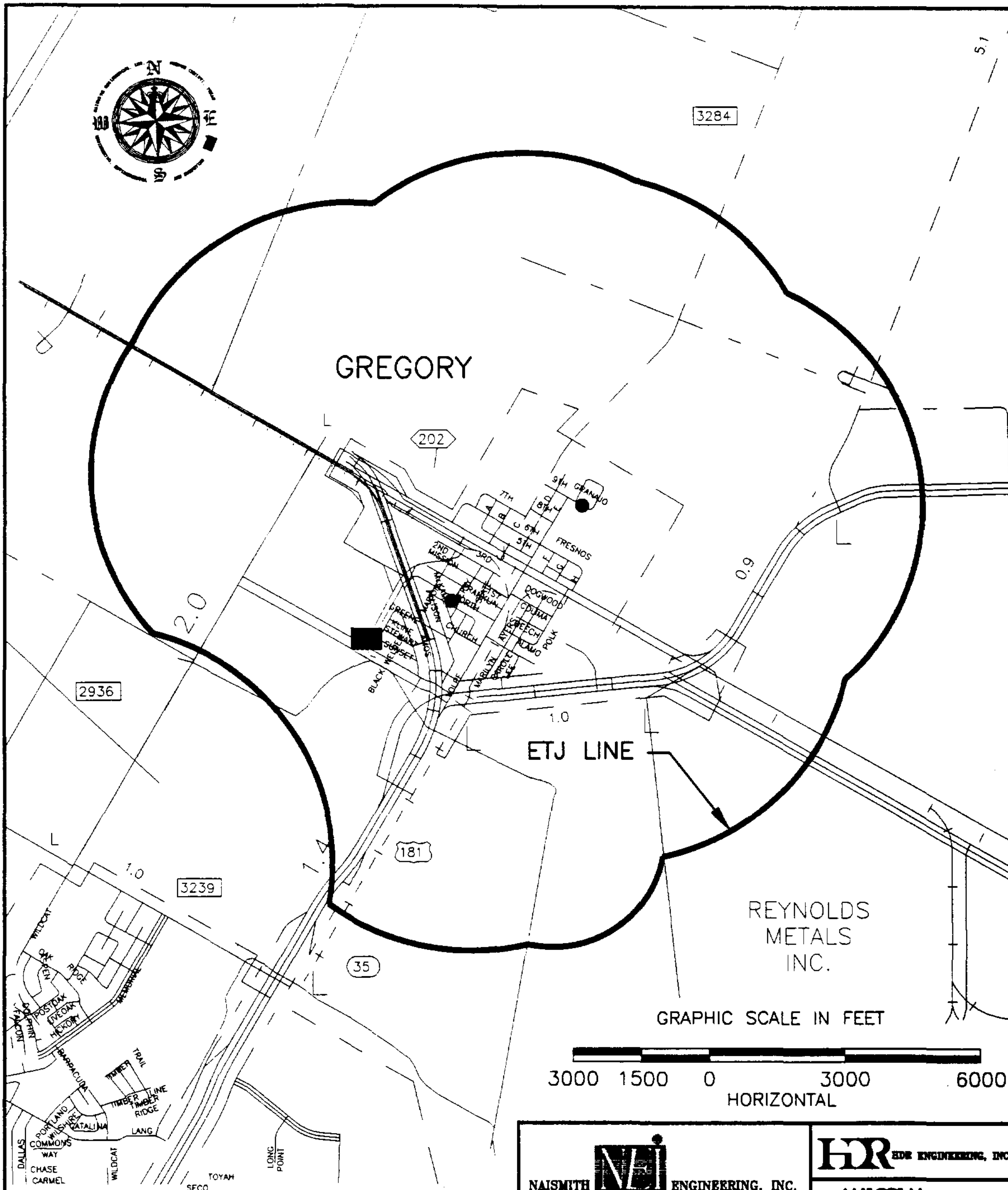
2.1.1.5.1 Collection System

Gregory's collection system consists of three lift stations and collection lines ranging from 6-inches to 12-inches in diameter. Sub-areas of the system are connected into a 12-inch gravity trunk sewer in Black Welder Street, which flows into the lift station at the treatment plant site (Figure 2-6).

2.1.1.5.2 Treatment Plant

The City's treatment plant uses an activated sludge extended aeration system in oxidation ditch, followed by clarification and chlorination prior to discharge into an unnamed drainage channel, then to Green Lake, then to Corpus Christi Bay in Segment No. 2481 of the Bays and Estuaries. The plant discharges under the following permits:

EPA NPDES Wastewater Permit No. TX0083062
TNRCC Permit No. 10092-001
Issued: April 17, 1992
Expires: April 17, 1997



LEGEND

- ● EXISTING WW LIFT STATION
- ■ EXISTING WWTP

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MALCOLM PIRNIE

NORTHSHORE PLANNING STUDY

GREGORY WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 6

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO: 3745–S13	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:	of

Permit limitations are as follows:

Effluent Characteristics	Discharge Limitations
Interim (through February 28, 1995)	
Average flow	0.32 mgd
2-hour peak flow	222 gpm
BOD_5	20 mg/L
TSS	20 mg/L
Dissolved Oxygen (minimum)	2.0 mg/L
Final (beginning March 1, 1995)	
Average flow	0.32 mgd
2-hour peak flow	222 gpm
BOD_5	10 mg/L
TSS	15 mg/L
Ammonia Nitrogen	3 mg/L
Dissolved Oxygen (minimum)	4.0 mg/L

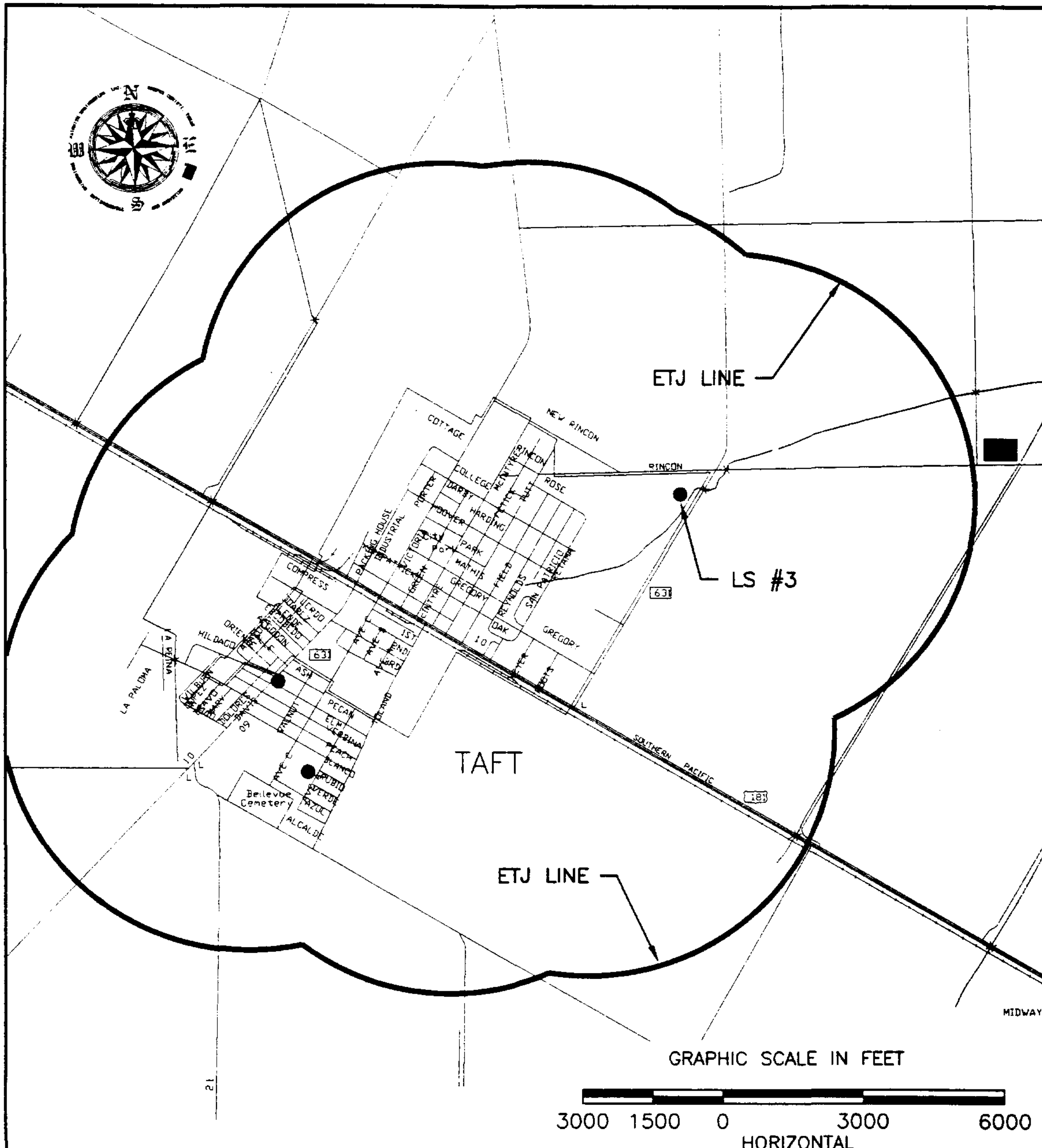
2.1.1.6 Taft

2.1.1.6.1 Collection System

Taft's collection system consists of three lift stations and collection lines ranging from 8-inches to 15-inches in diameter. Sub-areas of the system are connected to a 15-inch gravity trunk sewer that flows to Lift Station No. 3 in the northeastern portion of the City near Rincon Road and FM 631. Raw wastewater is then pumped through a 14-inch force main to the treatment plant, which is located approximately 1.5 miles northeast of the intersection of Rincon Road and FM 631 (Figure 2-7).

2.1.1.6.2 Treatment Plant

The City's treatment plant consists of an activated sludge extended aeration system in oxidation ditch followed by clarification and chlorination prior to discharge of effluent into the



LEGEND

- ● EXISTING WW LIFT STATION
- ■ EXISTING WWTP

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TAFT WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 7

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-S12	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

Taft drainage ditch, then to Copano Bay in Segment No. 2472 of the San Antonio-Nueces Coastal Basin. The plant discharges under the following Permits:

TNRCC Permit No. 10705-001
Issued: February 28, 1991
Expires: February 28, 1996

Permit limitations are as follows:

Effluent Characteristics	Discharge Limitations
Average flow	0.9 mgd
2-hour peak flow	1869 gpm
BOD_5	10 mg/L
TSS	15 mg/L
Ammonia Nitrogen	3 mg/L
Dissolved Oxygen (minimum)	4.0 mg/L

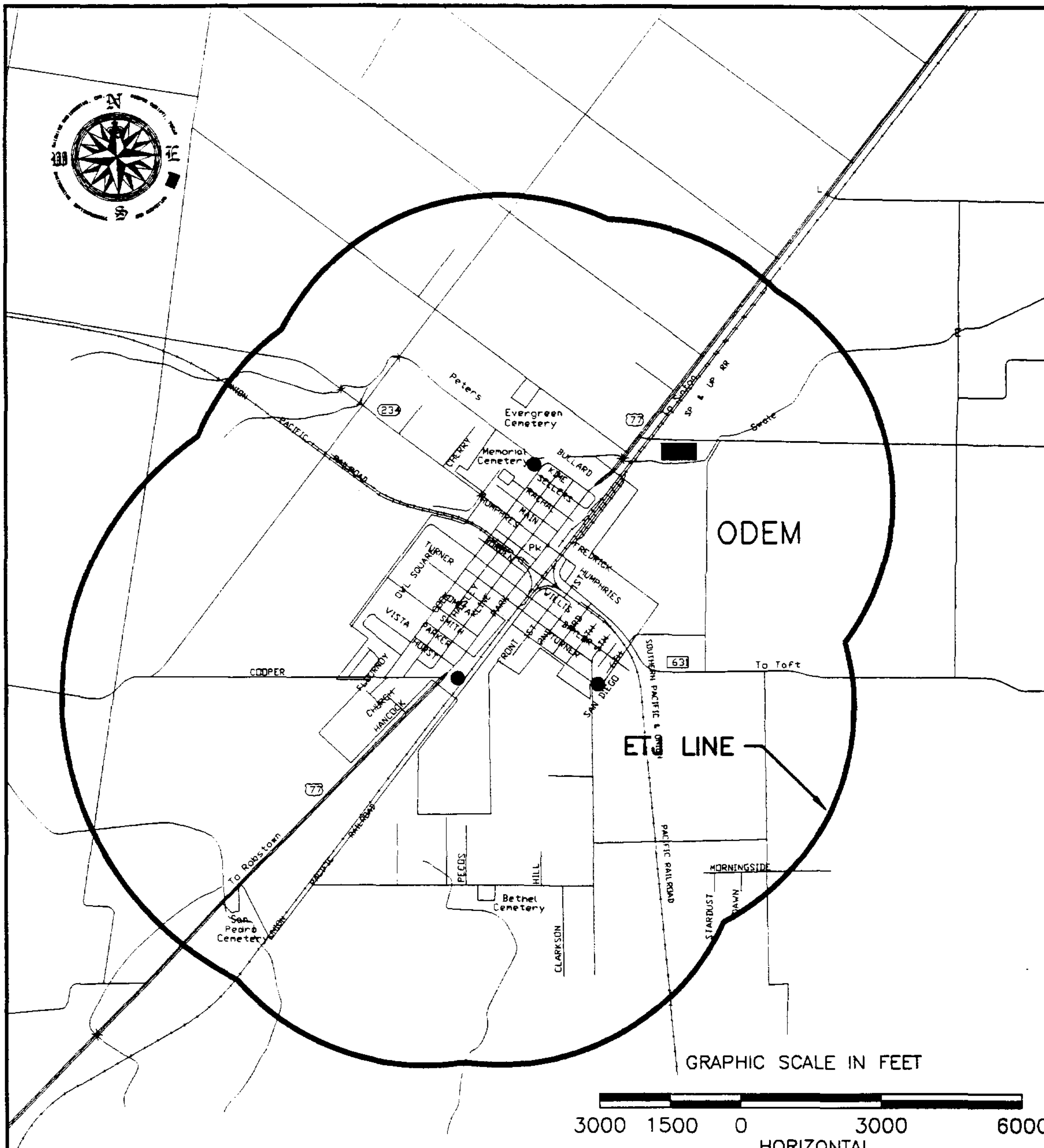
2.1.1.7 Odem

2.1.1.7.1 Collection System

Odem's collection system consists of three lift stations and collection lines ranging from 8-inches to 15-inches in diameter. Sub-areas of the system are connected into a 12-inch gravity trunk sewer that extends north of the City on U.S. 77 right-of-way to the treatment plant, located on the north side of Peters Swale and east of U.S. 77 (Figure 2-8).

2.1.1.7.2 Treatment Plant

The City's treatment plant components consist of an on-site lift station, Imhoff tank, pond aeration basin, primary and secondary stabilization ponds and sludge drying beds. Based on the long detention time in the pond system, chlorination is not required prior to discharge. Effluent is discharged directly into Peters Swale, then to Chiltipin Creek, then to Aransas River Tidal in Segment No. 2003 of the San Antonio-Nueces Council Basin. The plant discharges under the following permits:



LEGEND

● EXISTING WW LIFT STATION

■ EXISTING WWTP

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ODEM WASTEWATER PUMPING AND TREATMENT INFRASTRUCTURE

FIGURE 2 - 8

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-S11	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

EPA NPDES Wastewater Permit No. TX0025135
TNRCC Permit No. 10237-001
Issued: June 27, 1991
Expires: June 27, 1996

Permit limitations are as follows:

Effluent Characteristics	Discharge Limitations
Average flow	0.273 mgd
2-hour peak flow	N/A
BOD_5	30 mg/L
TSS	90 mg/L
Dissolved Oxygen (minimum)	4.0 mg/L

2.1.2 Existing Major Industrial Wastewater Collection and Treatment Infrastructure

2.1.2.1 Reynolds Metals Company

Reynolds operates a zero discharge domestic wastewater treatment facility that recycles all effluent by discharging onto tailings bed #18. The facility to discharge to bed #18 was completed in March, 1993. Prior to that time, WWTP effluent was discharged into Reynolds' east ditch and recirculated into the plant. Flow is currently not metered, but is estimated to be approximately 20,000 gpd.

2.1.2.2 E.I. DuPont de Nemours and Company

TNRCC Permit No. 01651 (NPDES Permit No. TX0008907) authorizes DuPont to treat and dispose of wastes from a freon fluorocarbons plant, a freon alternative plant, a cyclohexane plant, and a caustic chlorine plant. The permit authorizes discharge of an average daily flow not to exceed 3.1 mgd. The permit includes limitations on the following effluent characteristics: BOD_5, TSS, Total Organic Carbon (TOC), Oil and Grease, and numerous metals and hydrocarbon compounds. In addition to flow from DuPont, the DuPont facility also treats domestic wastewater and uncontaminated stormwater from the adjacent Occidental Chemical Corporation (Oxychem) facility. TNRCC Permit No. 01651 expires in November, 1995.

2.1.2.3 Occidental Chemical Corporation

Oxychem operates a treatment facility that disposes of wastes from its chemical manufacturing plant. The plant produces vinyl chloride monomer (VCM) and 1, 2 dichloroethane (EDC). The permit authorizes discharge of an average daily flow not to exceed 1.6 mgd. The permit includes limitations on the following effluent characteristics: BOD_5, TSS, Copper and numerous hydrocarbon compounds; the permit expires in March, 1997.

2.1.3 Determination of Wastewater Flow

2.1.3.1 Population Projections

Evaluation of the regional potential for effluent reuse to increase the area's water supply requires estimates of anticipated population growth. The population projections, along with per capita water usage and per capita wastewater flows, were then used to estimate future water demands and wastewater flows. Previous reports and various sources of population projections were reviewed to determine the most appropriate projections for this study.

The Texas Water Development Board (TWDB) makes population projections to update the Texas Water Plan. The TWDB projections are based upon vital statistics of each respective area and estimates of migration. The most current projections of population by the TWDB are dated April, 1992 and include Low Series and High Series forecasts. Projections are given for each city in San Patricio County for the years 2000, 2010, 2020, 2030 and 2040.

The Coastal Bend Council of Governments (CBCOG) has historically utilized an average of the TWDB's Low Series and High Series projections to update its Water Quality Management Plan. The most recent CBCOG update was published in March , 1992 and is based on TWDB projections dated June, 1991. No comprehensive locally derived population projections were available. However, experience has shown that local projections generally tend to be higher than state projections. In addition, recent TWDB forecasts for rates of population growth have generally been lower than in previous years.

For purposes of this study, it was determined that an average of the April, 1992 TWDB Low and High Series projections was the most reasonable estimate of future population in the area (Table 2-1).

2.1.3.2 Gallons Per Capita Per Day Wastewater Flow

Flow records were obtained from each municipal wastewater treatment plant for the calendar years 1990 and 1992 (Table 2-2). Flows from calendar year 1990 are representative of annual periods during the past approximately 20 years that recorded below average rainfall. Flows from calendar year 1992 are representative of annual periods during the past approximately 20 years that recorded above average rainfall. The average daily flow, and previously presented population data were used to calculate gallons per capita per day (gpd) wastewater flows for each City (Table 2-3). Thirty day average flows were also calculated (Table 2-4).

TABLE 2-1

STUDY AREA POPULATION PROJECTIONS

Study Area	1990	1995	2000	2005	2010	2015	2020	1990-2020 Increase	1990-2020 Average Annual Change %
Aransas Pass									
COG		7651	8121	8703	9284	---	---		
TWDB-Low Series		7633	8087	8650	9213	9847	10480		
TWDB-High Series		7676	8171	8772	9373	10080	10787		
TWDB Average	7180	7655	8129	8711	9293	9964	10634	3454	1.3%
Gregory									
COG		2856	3253	3674	4095	---	---		
TWDB-Low Series		2805	3152	3580	4007	4293	4578		
TWDB-High Series		2886	3314	3763	4212	4591	4970		
TWDB Average	2458	2846	3233	3672	4110	4442	4774	2316	2.0%
Ingleside									
COG		6344	6992	7688	8383	---	---		
TWDB-Low Series		6275	6854	7403	7952	8426	8900		
TWDB-High Series		6414	7131	7864	8597	9280	9963		
TWDB Average	5695	6345	6993	7834	8275	8853	9432	3735	1.5%
Ingleside on the Bay									
NEI Estimate	580	632	684	842	1000	1000	1000	420	1.5%
Odem									
COG		2394	2421	2589	2756	---	---		
TWDB-Low Series		2416	2465	2635	2805	2999	3193		
TWDB-High Series		2418	2469	2648	2826	3031	3236		
TWDB Average	2366	2417	2467	2642	2816	3015	3215	849	1.0%

TABLE 2-1 - Continued

STUDY AREA POPULATION PROJECTIONS

Study Area	1990	1995	2000	2005	2010	2015	2020	1990-2020 Increase	1990-2020 Average Annual Change %
Portland									
COG		12881	13537	14360	15183	---	---		
TWDB-Low Series		12849	13474	14134	14794	15365	15935		
TWDB-High Series		13011	13797	14657	15517	16314	17111		
TWDB Average	12224	12930	13636	14396	15156	15840	16523	4299	1.0%
Sinton									
COG		5849	6148	6576	7003	---	---		
TWDB-Low Series		5905	6260	6694	7127	7620	8113		
TWDB-High Series		5910	6270	6726	7181	7702	8223		
TWDB Average	5549	5908	6265	6710	7154	7661	8168	2619	1.2%
Taft									
COG		3231	3239	3463	3687	---	---		
TWDB-Low Series		3480	3737	3879	4021	4144	4267		
TWDB-High Series		3515	3807	3992	4177	4349	4520		
TWDB Average	3222	3498	3772	3936	4099	4246	4394	1172	1.0%
Taft Southwest									
TWDB-Low Series		2084	2156	2191	2226	2257	2287		
TWDB-High Series		2093	2173	2219	2265	2307	2349		
TWDB Average	2012	2089	2165	2205	2246	2282	2318	306	0.5%

TABLE 2-1 - Continued

STUDY AREA POPULATION PROJECTIONS

Other Cities	1990	1995	2000	2005	2010	2015	2020	1990-2020 Increase	1990-2020 Average Annual Change %
Port Aransas									
COG		2343	2452	2539	2625	---	---		
TWDB-Low Series		2359	2484	2595	2705	2909	3112		
TWDB-High Series		2360	2486	2597	2708	2914	3119		
TWDB Average	2233	2360	2485	2596	2707	2911	3116	883	1.1%
Rockport									
COG		5540	6327	7088	7849	---	---		
TWDB-Low Series		5027	5660	6174	6688	7172	7656		
TWDB-High Series		5403	6053	6830	7607	8493	9378		
TWDB Average	4753	5305	5857	6502	7148	7832	8517	3764	1.9%

TABLE 2-2
1990 & 1992 WASTEWATER AVERAGE DAILY FLOWS
(30-DAY AVERAGE IN MGD)

Month/Year	Aransas Pass	Gregory	Ingleside	Odem	Portland (Main)	Portland (N. Shore)	Portland (Total)	Sinton	Taft	Total
Jan-90	0.681	0.201	0.269	0.136	1.084	0.033	1.117	0.518	0.332	3.254
Feb-90	0.713	0.145	0.359	0.114	1.171	0.058	1.229	0.513	0.369	3.442
Mar-90	0.799	0.146	0.369	0.141	1.212	0.070	1.282	0.498	0.419	3.654
Apr-90	0.793	0.143	0.234	0.140	1.370	0.074	1.444	0.583	0.452	3.789
May-90	0.801	0.140	0.333	0.112	1.193	0.054	1.247	0.534	0.434	3.601
Jun-90	0.712	0.122	0.347	0.079	1.171	0.032	1.203	0.491	0.437	3.391
Jul-90	0.821	0.135	0.327	0.091	1.214	0.041	1.255	0.663	0.441	3.733
Aug-90	0.820	0.120	0.391	0.101	0.959	0.029	0.988	0.516	0.437	3.373
Sept-90	0.790	0.134	0.430	0.106	1.003	0.032	1.035	0.305	0.463	3.263
Oct-90	0.774	0.126	0.278	0.104	0.931	0.060	0.991	0.330	0.439	3.042
Nov-90	0.802	0.142	0.272	0.123	0.918	0.025	0.943	0.194	0.408	2.884
Dec-90	0.752	0.143	0.272	0.109	0.928	0.039	0.967	0.205	0.382	2.830
Average	0.772	0.141	0.323	0.113	1.096	0.046	1.142	0.446	0.418	3.355
Jan-92	1.319	0.220	0.460	0.187	1.144	0.026	1.170	0.556	0.561	4.473
Feb-92	1.346	0.327	0.571	0.180	1.108	0.046	1.154	0.665	0.544	4.787
Mar-92	0.967	0.206	0.357	0.131	1.091	0.037	1.128	0.469	0.488	3.746
Apr-92	1.075	0.316	0.512	0.132	1.104	0.038	1.142	0.682	0.593	4.452
May-92	1.128	0.320	1.083	0.143	1.213	0.038	1.251	0.695	0.600	5.220
Jun-92	1.061	0.321	0.789	0.147	1.189	0.049	1.238	0.576	0.460	4.592
Jul-92	0.756	0.196	0.403	0.045	1.017	0.048	1.065	0.379	0.458	3.302
Aug-92	0.738	0.187	0.354	0.082	1.039	0.046	1.085	0.363	0.497	3.306
Sep-92	0.739	0.181	0.351	0.068	1.066	0.044	1.110	0.424	0.472	3.345
Oct-92	0.736	0.220	0.323	0.094	1.122	0.049	1.171	0.373	0.445	3.362
Nov-92	0.747	0.181	0.220	0.169	1.049	0.050	1.099	0.526	0.521	3.463
Dec-92	0.779	0.161	0.175	0.122	1.007	0.037	1.044	0.491	0.445	3.217
Average	0.949	0.236	0.467	0.125	1.096	0.042	1.138	0.517	0.507	3.939

TABLE 2-3

SUMMARY OF WASTEWATER AVERAGE DAILY FLOW (ADF) AND PER CAPITA FLOW (1990 AND 1992)

City	1990			1992			1990 & 1992 Average Per Capita Flow (GPCD)
	Population Estimate	ADF (MGD)	Per Capita Flow (GPCD)	Population Estimate	ADF (MGD)	Per Capita Flow (GPCD)	
Aransas Pass	7180	0.722	101	7418	0.949	128	115
Gregory	2458	0.141	57	2652	0.236	89	74
Ingleside	5696	0.323	57	6020	0.467	77	67
Odem	2366	0.113	48	2392	0.125	52	50
Portland	12224	1.142	93	12577	1.138	90	92
Sinton	5549	0.446	80	5729	0.517	90	85
Taft	5234	0.418	80	5411	0.507	94	87

TABLE 2-4

SUMMARY OF WASTEWATER EFFLUENT DATA

City	Period	30 Day Avg. Flow (MGD)	BOD5		TSS	
			(MG/L)	(LBS/DAY)	(MG/L)	(LBS/DAY)
Aransas Pass	4/91 - 3/92	0.92	2.7	20.7	4.9	37.6
Gregory	4/91 - 3/92	0.21	3.3	5.8	12.4	21.7
Ingleside	4/91 - 3/92	0.40	3.6	12.0	6.4	21.4
Odem	4/91 - 3/92	0.14	20.6	24.1	66.0	77.1
Portland (1)	4/91 - 3/92	1.09	6.8	61.8	3.5	31.8
Sinton	4/91 - 3/92	0.45	23.9	89.7	49.0	183.9
Taft	4/91 - 3/92	0.48	3.4	13.6	3.7	14.8
TOTALS		3.69	7.4	227.7	12.6	388.3

(1) Combined values for both Portland plants

2.1.3.3 Projected Average Daily Wastewater Flows

Wastewater flows were projected for the years 2000, 2010, and 2020 by using the population projections presented in Section 2.1.3.1 and calculated per capita wastewater flows. The projected average daily wastewater flows are based on an average of the 1990 and 1992 per capita flows (Table 2-5).

Actual per capita flows showed a wide variation, which is dependent upon the unique characteristics of the service area in each city. All of the cities, with the exception of Aransas Pass, showed actual gpcd flows that were less than 100 gpcd (value recommended by TNRCC for planning purposes in the absence of actual data) (Table 2-5). Projections of revenue generated by effluent flows, that are presented in this study, are based on the actual per capita flows (Table 2-5). Sizes of collection and treatment facilities are based on the recommended 100 gpcd, except for Aransas Pass (actual value of 115 gpcd used).

2.2 Feasibility of Regional Effluent Reuse

Previous wastewater master plans for municipalities in the Northshore area were reviewed to evaluate how new wastewater treatment plants or expansions could be incorporated into a regional plan for reuse of treated effluent. Master Plans, studies and reports that were reviewed include:

- City of Portland Comprehensive Plan, Coastal Bend Regional Planning Commission, February 1971.
- Report on Sludge Dewatering for City of Portland, NEI, March 1993.
- Live Oak Ridge Regional Water and Wastewater Master Plan, NEI, August 1989.

TABLE 2-5

PROJECTED AVERAGE DAILY WASTEWATER FLOWS

City	Year	Population	Per Capita Flow (GPCD)		Average Daily Flow (MGD)	
			Actual Value	Recommended Planning Value	Actual Value	Recommended Planning Value
Aransas Pass	1990	7180	115	115	0.83	0.83
	2000	8129			0.93	0.93
	2010	9293			1.07	1.07
	2020	10634			1.22	1.22
Gregory	1990	2458	74	100	0.18	0.25
	2000	3233			0.24	0.32
	2010	4110			0.30	0.41
	2020	4774			0.35	0.48
Ingleside	1990	5695	67	100	0.38	0.57
	2000	6993			0.47	0.70
	2010	8275			0.55	0.83
	2020	9432			0.63	0.94
Ingleside on the Bay	1990	580	-	100	-	0.06
	2000	684			-	0.07
	2010	1000			-	0.10
	2020	1000			-	0.10
Odem	1990	2366	50	100	0.12	0.24
	2000	2467			0.12	0.25
	2010	2816			0.14	0.28
	2020	3215			0.16	0.32
Portland	1990	12224	92	100	1.12	1.22
	2000	13636			1.25	1.36
	2010	15156			1.39	1.52
	2020	16523			1.52	1.65
Sinton	1990	5549	85	100	0.47	0.55
	2000	6265			0.53	0.63
	2010	7154			0.61	0.72
	2020	8168			0.69	0.82
Taft (including Taft Southwest)	1990	5245	87	100	0.46	0.52
	2000	5937			0.52	0.59
	2010	6345			0.55	0.63
	2020	6712			0.58	0.67
Total	1990	41297	-	-	3.56	4.24
	2000	47344			4.06	4.85
	2010	54149			4.61	5.56
	2020	60458			5.15	6.20

- Nueces Estuary Regional Wastewater Planning Study - Phases I and II, HDR Engineering, Inc., March, 1993.
- Engineering Study and Report for Improvements to the City of Sinton's Public Utility and Infrastructure Systems, NEI, August 1992.
- Preliminary Engineering Study and Report for Improvements to the City of Ingleside Wastewater Collection and Treatment Facilities, Archie Walker Engineering, Inc., September 1988.
- Homeport Wastewater Project - Evaluation of Possible Sites for Wastewater Treatment Facilities, Archie Walker Engineering, Inc., June 1988.
- Comprehensive Plan for the City of Odem, NEI, May 1976.
- 1984 Water and Sewer System Improvements, City of Odem, NEI, July 1984.
- Environmental Assessment for Proposed Eastern San Patricio County, Texas Subregional Wastewater Treatment Facility, NEI, May 1979.
- Sinton Comprehensive Plan, Bernard Johnson Engineers, Inc., July 1970.
- Sanitary Sewer System Evaluation Survey Report for the Cities of Aransas Pass, Gregory and Ingleside, Texas, Geo-Marine Inc., November 1978.
- Analysis of Infiltration and Inflow for the Cities of Taft, Gregory, Ingleside and Aransas Pass, Texas, Geo-Marine Inc., December 1976.
- An Analysis of Infiltration in the Sanitary Sewer System of Gregory, Texas, Geo-Marine, Inc., July 1976.
- City of Taft Comprehensive Plan, Urban Engineering, January 1989.

In addition, the effects of effluent discharge locations were evaluated to determine if plant modifications would be necessary to meet potential reuse requirements. The Texas Natural Resource Conservation Commission (TNRCC) regulations (31 TAC Chapter 310), specify reclaimed water quality requirements, depending on the specific end use of the reclaimed water. The reuse categories and effluent requirements (30-day average values) that are applicable to the Northshore area WWTP's are:

- Irrigation of restricted landscape areas (defined as land which has had its plant cover modified and access to which may be controlled in some manner). Examples of such areas are: golf courses; cemeteries; roadway right-of-ways; median dividers).

  BOD_5 - 20 mg/L (system other than pond system)
  BOD_5 - 30 mg/L (pond system)
  Fecal coliform - not to exceed 800 CFU/100 mL (requires additional disinfection at the storage site if it is stored for a period of 24-hours or longer, based on daily average flow rates).

- Commercial and industrial use

  BOD_5 - 20 mg/L (system other than pond system)
  BOD_5 - 30 mg/L (pond system)
  Fecal coliform - not to exceed 200 CFU/100 mL

2.2.1 Aransas Pass

The Live Oak Ridge Water and Wastewater Master Plan was completed in August, 1989 for the San Patricio Municipal Water District. TWDB's 1988 population projections presented in the Master Plan are approximately 16 percent higher than those presented in this study. Using the higher projections, the Master Plan estimated that flow to the Aransas Pass WWTP would exceed its hydraulic capacity by the year 2010. Collection system expansion alternatives that were presented included the addition of new pump stations along FM 1069, north and south of SH 35. The Master Plan included flexibility to allow future treatment capacity to be added to the existing plant or at a new plant located in the area northwest of the intersection of SH 35 and FM 1069.

In either scenario, the City's treatment plant or plants could be incorporated into a regional plan for reuse. In the case of the existing WWTP, the existing discharge could be diverted into pumping and transmission facilities that would pump effluent for regional reuse. In the case of a future northwest area plant, the process could be designed to achieve the required effluent limitations. In addition, pumping and transmission facilities could be incorporated into the design to provide effluent for reuse.

Decisions regarding construction of a new plant or continued utilization of the existing plant will depend on several factors, including:

- Future changes in the growth areas and population growth rate.
- Continued deterioration of plant infrastructure with age.
- On-going and increasing maintenance requirements as the plant ages.
- Whether future plant upgrades will be required by more stringent effluent limitations.

Aransas Pass is currently under an Administrative Order from the TNRCC and EPA to install dechlorination facilities by August 1994. Budget estimates include a project cost of approximately $466,000 to install ultraviolet (UV) disinfection facilities at the plant. The City has requested approval from the regulatory agencies to install a less expensive manual feed sodium thiosulfate system for dechlorination. This system has an initial capital cost of approximately $10,000 and annual operating cost of approximately $15,000. Based on the most recent annual inspection of the WWTP by TNRCC, certain aeration basin and clarifier modifications are also required. The total project cost of these modifications is approximately $35,000.

In addition, the City has experienced sludge dewatering problems caused by inadequate sludge thickening and drying facilities. Budget estimates include a project cost of approximately $350,000 to rehabilitate the existing sludge holding basin and approximately $50,000 to rehabilitate the existing vacuum beds. The cost of additional sand drying beds is approximately $175,000. As an alternative to these costs, the City obtained a permit in late 1993 for disposal of its sludge in a two-year test project at the Reynolds Metals Plant tailings beds. If this program is extended in the future, the necessity of sludge thickening and dewatering improvements may be delayed or eliminated altogether.

TNRCC regulations would allow the City's existing effluent (20 mg/L BOD_5 - 20 mg/L TSS) to be reused for irrigation of restricted landscape areas or industrial use.

If the discharge point is relocated to a freshwater lake (such as Green Lake), more stringent effluent limitations (10 mg/L BOD_5 - 15 mg/L TSS - 3 mg/L ammonia nitrogen) will likely be required.

In addition, based on the fact that flows from the plant exceed 1 mgd, it is likely that renewal of the discharge permit at its present location will require more stringent effluent limitations (10 mg/l BOD_5 -15 mg/l TSS - 3 mg/L ammonia nitrogen) and biomonitoring. Plant modifications will be required to meet these criteria.

2.2.2 Ingleside

A master plan for Ingleside's wastewater collection system was also presented in the Live Oak Ridge Water and Wastewater Master Plan. TWDB's 1988 population projections presented in the Master Plan are approximately 18 percent higher than those presented in this study. Even if the higher projections are used, the City has excess wastewater treatment capacity beyond the year 2020 because of the additional 1 mgd expansion that was completed to serve the Navy's Homeport Facility.

Recommendations for collection system expansion included the addition of a new pump station along FM 1069 near Morgan Lane to serve future development north of the existing collection system. The southeastern portion of the service area would be served by a new pump station south of Sixth Street and east of Avenue A.

Raw wastewater from existing and future collection system expansions would flow to the Eighth Street Lift Station at the WWTP site. Construction of effluent pumping and transmission facilities at the plant site could divert the existing discharge from Kinney Bayou for regional reuse.

TNRCC regulations would allow the City's existing effluent (10 mg/L BOD_5 - 15 mg/l TSS - 3 mg/L ammonia nitrogen) to be reused for irrigation of restricted landscape areas or industrial use.

Due to the fact that the City's existing discharge permit requires nitrification and dechlorination, additional plant modifications will likely not be required for relocation of the existing discharge point.

2.2.3 Portland

Recent master planning for the City of Portland's wastewater system has included a plan to abandon the existing Northshore Wastewater Treatment Plant and treat all flow at the City's Main Plant. The Main Plant could be incorporated into a regional plan for reuse by diverting the existing discharge from Nueces Bay into pumping and transmission facilities. Future expansion of the City's collection system to areas that are not currently served could also be designed to send all flows to the Main Plant or directly to a future regional plant. Based on population projections and a recommended planning value for per capita wastewater flow of 100 gpcd, which is in excess of the actual flow calculated in this study (92 gpcd), the existing WWTP has sufficient capacity through the year 2020. However, decisions regarding the future of the Main Plant will depend on several factors, including:

- Future changes in the growth areas and population growth rate.
- Continued deterioration of plant infrastructure with age.
- Lack of space for expansion at the existing site.
- Whether future plant upgrades will be required by more stringent effluent limitations.
- On-going and increasing maintenance requirements as the plant ages.

Portland is currently under an Administrative Order from the EPA to either install dechlorination facilities or divert its effluent for reuse by August 1994. Budget estimates include a project cost of approximately \$400,000 to install UV disinfection facilities at the plant. In addition, the City has experienced sludge dewatering and disposal problems at the Main Plant and has evaluated various solutions. Budget estimates for capital costs ranged from \$250,000 - \$300,000. As an alternative, Portland is also participating in the two-year test project at the Reynolds Metals Plant (as discussed in Section 2.2.1).

TNRCC regulations would allow the City's existing effluent (20 mg/L BOD_5 - 20 mg/L TSS) to be reused for irrigation of restricted landscape areas or industrial use. However, if the discharge point is relocated to a freshwater lake (such as Green Lake), more stringent effluent limitations (10 mg/l BOD_5 - 15 mg/L TSS - 3 mg/L ammonia nitrogen) will likely be required.

In addition, based on the fact that flow from the plant exceeds 1 mgd, it is likely that renewal of the discharge permit at its present location will require more stringent effluent limitations (10 mg/l BOD_5 - 15 mg/L TSS - 3 mg/L ammonia nitrogen) and biomonitoring. The size and location of the existing site limit the space available for additional required facilities.

2.2.4 Gregory

Certain portions of the City's service area that are currently undeveloped have access to the existing wastewater collection system. Future extension of service to other areas that are currently undeveloped will require additional lift stations and force mains, or gravity trunk sewers.

Based on population projections and the actual per capita wastewater flow calculated in this study (74 gpcd), the plant will need to be expanded prior to the year 2010. Depending upon the feasibility of a regional WWTP at that time, raw wastewater from areas currently not served by the existing system could either be pumped to the existing plant or directly to the regional plant. The existing WWTP discharge could be diverted into pumping and transmission facilities that would pump effluent for regional reuse.

TNRCC regulations would allow the City's existing effluent (currently 20 mg/l BOD_5 - 20 mg/L TSS) to be reused for irrigation of restricted landscape areas or industrial use. Gregory currently discharges into Green Lake and, therefore, its final effluent limitations (beginning March 1, 1995) have been set at 10 mg/l BOD_5 - 15 mg/L TSS - 3 mg/L ammonia nitrogen. It is not likely that dechlorination will be required, due to the fact that plant flow is less than 1 mgd.

Based on information from the City, the plant is currently meeting the more stringent limitations that will be required in 1995. Current flow is approximately 60 percent of the design flow. As the flow increases, it is possible that future upgrades will be required to meet the 10-15-3 permit. Recent improvements at the plant include rehabilitation of the oxidation ditch rotors.

Additional improvements that are planned include: rehabilitation of the plant lift station and the main collection system lift station; lining of certain existing collection system sewers to minimize inflow and infiltration; and repairs to the remainder of the collection system to minimize inflow.

2.2.5 Taft

The City's Comprehensive Plan includes an inventory of the existing wastewater collection and treatment system, and recommendations for improvements. Most of the City's planning area has access to the existing wastewater collection system. Future extension of service to some areas that are currently undeveloped will require additional lift stations and force mains, or gravity trunk sewers. All wastewater from the collection system would flow to Lift Station No. 3 (Rincon Road at FM 631) and be pumped to the WWTP. Construction of effluent pumping and transmission facilities at the plant site could divert the existing discharge for regional reuse.

Based on population projections and a recommended planning value for per capita wastewater flow of 100 gpcd, which is in excess of the actual flow calculated in this study (87 gpcd), the existing WWTP will not require expansion until the year 2020.

As discussed for other cities in the area, decisions regarding the future of Taft's WWTP will depend on several factors, including:

- Future changes in the population growth rate.
- Continued deterioration of the plant infrastructure with age.
- On-going and increasing maintenance requirements as the plant ages.

TNRCC regulations would allow the City's existing effluent (10 mg/L BOD_5 - 15 mg/L TSS - 3 mg/L ammonia nitrogen) to be reused for irrigation of restricted landscape areas or industrial use.

Taft currently discharges into an effluent dominated stream and, therefore, its final effluent limitations have been set at 10 mg/L BOD_5 - 15 mg/L TSS - 3 mg/L ammonia nitrogen. It is not likely that dechlorination will be required, due to the fact that plant flow is less than 1 mgd.

2.2.6 Sinton

Collection system extensions have recently been constructed to serve unincorporated subdivisions located south of the City. Certain portions of currently undeveloped areas within the City's service area have access to the existing collection system. Future extensions of service to other areas that are currently undeveloped will require additional lift stations and force mains, or gravity trunk sewers. Construction of effluent pumping and transmission facilities at the plant site could then divert the existing discharge for regional reuse.

Based on population projections and a recommended planning value for per capita flow of 100 gpcd, a plant expansion will need to be done prior to the year 2000.

The major considerations regarding the future of the facility include:

- Age of the facility
- Existing hydraulic capacity of the plant headworks and primary clarifier
- Seasonal upsets in lagoon system
- Future expansion requirements

The original treatment facilities have served in excess of forty years without development of new or larger system units. Plant improvements made in 1983 included rehabilitation/replacement of certain mechanical equipment and construction of the lagoons. Currently, some treatment units are hydraulically and organically overloaded and the plant only marginally meets effluent limitations (renewed over the past year at 30 mg/L BOD-90 mg/L TSS). The lagoons provide for polishing and peak discharge treatment capabilities, but have also experienced seasonal upsets that result in high TSS concentrations. The City is currently in the process of evaluating alternative solutions for wastewater treatment improvements and has budgeted in excess of $1,000,000 for the project.

TNRCC regulations would allow the City's existing effluent (30 mg/L BOD_5 - 90 mg/L TSS) to be reused for irrigation of restricted landscape areas or industrial use. If the discharge point is relocated to a freshwater lake (such as Green Lake), more stringent effluent limitations will likely be required.

2.2.7 Odem

Similar to other cities in the area, certain portions of the City's service area that are currently undeveloped have access to the existing wastewater collection system. Future extension of service to other areas that are currently undeveloped will require additional lift stations and force mains, or gravity trunk sewers. Construction of effluent pumping and transmission facilities at the plant site could divert the existing discharge for regional reuse.

Based on population projections and a recommended planning value for per capita flow of 100 gpcd, the plant will need to be expanded prior to the year 2010.

The existing plant was originally constructed in the late 1960's. Improvements and additions made in 1985 included construction of the pond aeration basin, Imhoff tank effluent piping, aeration basin effluent piping and effluent control structure, piping additions from the lift station to the aeration basin, modifications to the lift station, excavation of ponds and rebuilding of levees. The major considerations regarding the future of the facility include:

- Age of the facility

- Future expansion requirements

- Whether future plant upgrades will be required by more stringent effluent limitations.

- On-going and increasing maintenance requirements as the plant ages.

TNRCC regulations would allow the City's existing effluent (30 mg/L BOD_5 - 90 mg/L TSS) to be reused for irrigation of restricted landscape areas or industrial use. If the discharge point is relocated to a freshwater lake (such as Green Lake), more stringent effluent limitations will likely be required.

2.3 Municipal and Industrial Fresh Water Resources and Demands

2.3.1 Existing Fresh Water Resources and Infrastructure

The area's fresh water needs are served primarily by the San Patricio Municipal Water District's (SPMWD) system. The SPMWD was created in 1951 by a special act of the Texas Legislature for the purpose of providing a dependable supply of treated water from the Nueces River for the domestic and industrial users in San Patricio County and the surrounding area.

The SPMWD purchases all of its water from the City of Corpus Christi under a 30-year contract that expired in May, 1994. Both the SPMWD and Corpus Christi assume "wholesaler" roles in supplying water. The SPMWD's two contractual permits allow the use of 42,562 acre-feet of water annually for municipal and industrial purposes. The SPMWD services the following major customers:

- City of Aransas Pass
- City of Gregory
- City of Ingleside

- City of Ingleside on the Bay
- City of Odem
- City of Portland
- City of Taft
- Nueces County Water Control & Improvement District #4 (City of Port Aransas)
- Aransas County Conservation & Reclamation District (Cities of Rockport and Fulton)
- Reynolds Metals Company
- DuPont Company
- Oxychem Company
- Miscellaneous rural, domestic and commercial (Seaboard Water Supply Corporation and Rincon Water Supply Corporation)

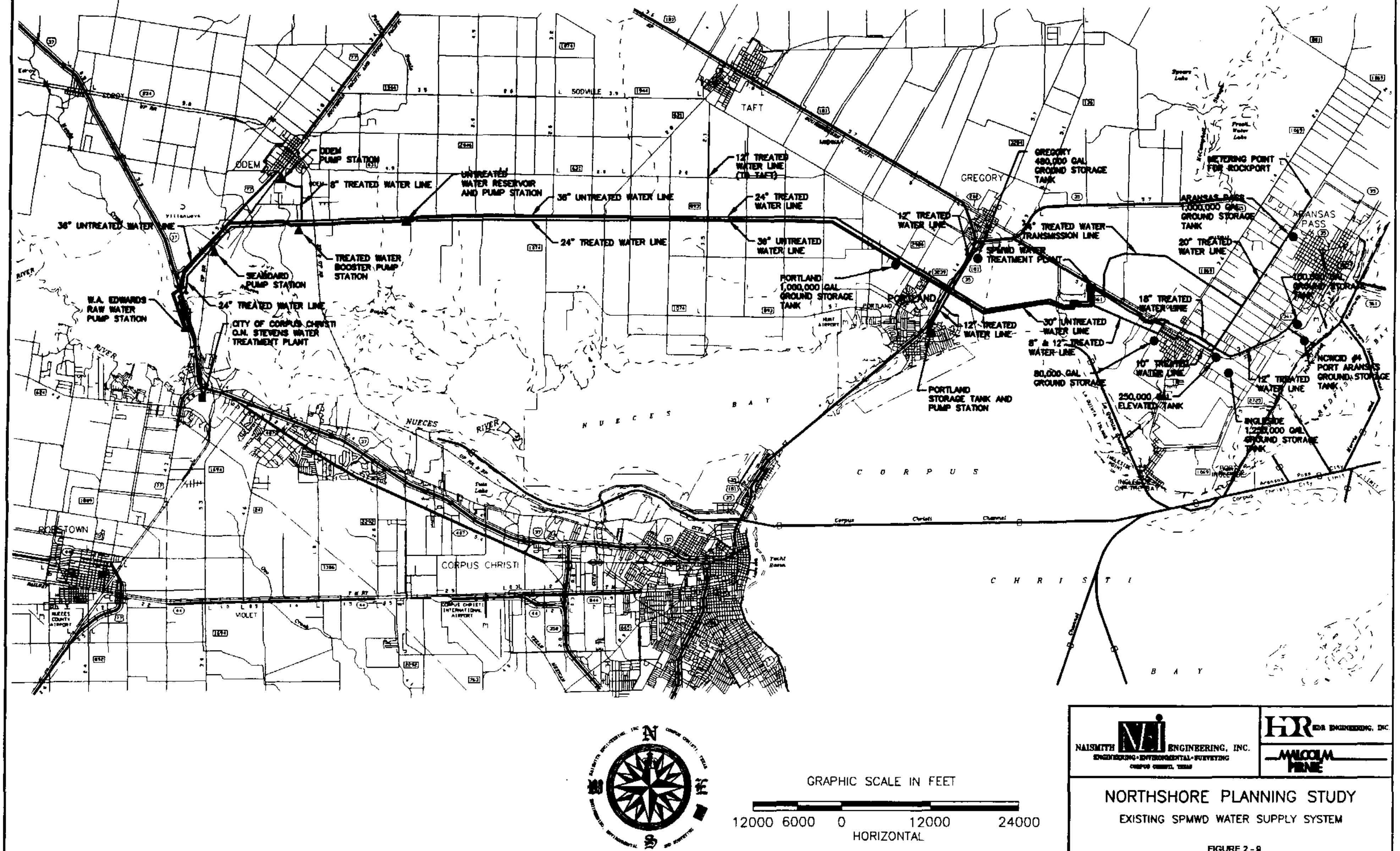
Major water supply facilities that are owned and operated by the SPMWD are described in the following section (Figure 2-9).

2.3.1.1 Treated Water Supply Facilities

The SPMWD currently has two ways by which to provide treated water. The first is through a 24-inch treated water line from the City of Corpus Christi's O. N. Stevens Water Treatment Plant. The 28-mile line was installed by the Reynolds Metals Company and later deeded to the City of Corpus Christi. The line was purchased by the SPMWD from the City in 1982. Water service is provided to the Cities of Odem, Taft, Gregory and Portland through this line.

Additional treated water supply facilities along the 24-inch line include:

- Water supply to the Seaboard Water Supply Corporation southwest of the City of Odem, including tap to 24-inch line, ground storage, pumps, pressure system and controls.



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EXISTING SPMWD WATER SUPPLY SYSTEM

FIGURE 2 - 9

E. BUSSEY	G. BRIDGES	AS NOTED	3745-WS1	1
G. BRIDGES	3745	4/94		

- Reynolds Booster Station located along the line south of the City of Odem.
- 8-inch treated water supply line to the City of Odem.
- 12-inch treated water connection to the City of Taft, with meter, pumping installation and controls.
- Rincon Water Supply Corporation connections south of Taft, including storage tanks and pumping installation.
- Tap on the 24-inch line at the northwest limits of Portland, including valves, flow meter, level controls and rate-of-flow controller that serves the City of Portland's 1,000,000 gallon ground storage and pumping station.
- Gregory-Portland pump station located at the intersection of U.S. Highway 181 and FM 3239, including 12-inch transmission lines to the cities of Gregory and Portland along U.S. Highway 181.

The capacity of the SPMWD's 24-inch treated water line from the City of Corpus Christi's water plant is approximately 6.5 mgd, without the booster station in operation and nine to 10 mgd with the booster station turned on.

The second way the SPMWD provides treated water is through the SPMWD's own treatment plant, which is located approximately three miles northwest of Ingleside on State Highway 361. This plant draws untreated water from a 12 million gallon ground storage reservoir (see Section 2.3.1.2 for further explanation) at the plant site and has a peak hydraulic capacity of approximately 10 mgd. Treatment capacity of the plant is approximately nine mgd. The plant can also receive treated water directly from the SPMWD's 24-inch line. Present peak day production from this plant has ranged between seven and eight mgd. The SPMWD's total treated water supply capacity is approximately 18 to 19 mgd (nine to 10 mgd from Corpus Christi through 24-inch line plus nine mgd from SPMWD water treatment plant).

Additional treated water supply facilities from the treatment plant include:

- 24-inch, 18-inch, 12-inch, 10-inch and 8-inch treated water transmission lines serving the cities of Ingleside and Aransas Pass; the Nueces County Water Control and Improvement District No. 4; and the Aransas county Conservation and Reclamation District (Rockport-Fulton area), respectively;
- Metering stations at each of the above service points (Aransas Pass has two separate metering points).
- 6-inch and 8-inch treated water lines serving industrial customers, complete with meters.
- 250,000 gallon elevated storage tank located at the intersection of SH 361 and Avenue "A".

See Tables 2-6, 2-7, and 2-8 for monthly totals of treated water sold by the SPMWD in 1992 and 1993, treated water sold by customer from the SPMWD's plant and water purchased from Corpus Christi, respectively, for 1992 and 1993.

2.3.1.2 Raw Water Supply Facilities

Raw water is taken directly from the Nueces River at the W. A. Edwards Nueces River Pump Station. It is then transported in a 36-inch, 28-mile transmission line to Reynolds Metals Company's raw water reservoir. From there, the line is reduced to 30-inches and continues to a point just outside the SPMWD's treatment plant property. The line is then reduced to 24-inches and continues to the 12 million gallon ground storage reservoir. This line is also connected to the headworks of the treatment plant, and is valved to allow raw water to be pumped directly into the plant, bypassing the reservoir. A connection is also provided from the ground storage reservoir to the E. I. DuPont de Nemours (DuPont) plant to supply process water. The SPMWD's plant typically uses the reservoir as its primary source of supply. The 36-inch transmission line was constructed in 1963-64. In 1972, the capacity of the line was

TABLE 2 -6
SPMWD TREATED WATER SYSTEM
WATER USE SUMMARY (1992 and 1993)

1992	Total Sold from Plant (MGD)	Total Purchased from C.C. (MGD)	Total Treated Water (MGD)
January	3.251	3.152	6.367
February	3.881	3.717	7.598
March	3.366	3.314	6.680
April	3.521	3.539	7.060
May	4.148	3.506	7.654
June	4.588	3.625	8.213
July	6.031	4.552	10.583
August	6.503	5.678	12.181
September	5.754	4.887	10.641
October	5.039	4.051	9.090
November	4.558	3.785	8.343
December	4.254	3.872	8.126
1992 Average	4.575	3.973	8.548

1993	Total Sold from Plant (MGD)	Total Purchased from C.C. (MGD)	Total Treated Water (MGD)
January	3.666	3.300	6.966
February	4.528	3.726	8.254
March	3.870	3.247	7.117
April	4.586	3.954	8.540
May	4.214	3.440	7.654
June	4.937	3.909	8.579
July	6.409	4.657	10.808
August	7.029	5.480	12.509
September	5.971	4.580	10.551
October	5.557	4.315	9.872
November	5.120	3.805	8.925
December	4.429	3.419	7.848
1993 Average	5.029	3.987	9.016

TABLE 2-7

SPMWD TREATED WATER USE (SOLD FROM PLANT) (IN MGD)

1992	Aransas Pass	Ingleside	Rockport	Port Aransas	Others (1)
January	1.295	0.538	1.346	0.046	0.026
February	1.575	0.685	1.597	0.000	0.024
March	1.308	0.528	1.509	0.000	0.022
April	1.326	0.616	1.555	0.000	0.024
May	1.407	0.612	1.865	0.238	0.027
June	1.512	0.597	1.957	0.493	0.029
July	1.782	0.727	2.501	0.987	0.034
August	1.841	0.842	2.733	1.042	0.038
September	1.761	0.743	2.443	0.761	0.047
October	1.634	0.667	2.105	0.582	0.061
November	1.668	0.607	1.739	0.501	0.043
December	1.679	0.550	1.577	0.402	0.047
1992 Average	1.567	0.643	1.911	0.388	0.035

(1) Water Corporation, Rural & Misc.

TABLE 2-7 - Continued

SPMWD TREATED WATER USE (SOLD FROM PLANT) (IN MGD)

1993	Aransas Pass	Ingleside	Rockport	Port Aransas	Others
January	1.357	0.497	1.339	0.436	0.0.7
February	1.732	0.647	1.686	0.431	0.033
March	1.395	0.560	1.480	0.395	0.040
April	1.580	0.654	1.905	0.413	0.034
May	1.383	0.650	1.699	0.450	0.033
June	1.634	0.675	2.059	0.536	0.033
July	1.812	0.774	2.698	1.091	0.035
August	2.035	0.922	3.107	0.921	0.043
September	1.798	0.790	2.632	0.717	0.034
October	1.660	0.795	2.261	0.778	0.038
November	1.640	0.763	1.939	0.746	0.031
December	1.531	0.742	1.733	0.388	0.035
1993 Average	1.631	0.706	2.047	0.610	0.031

(1) Water Corporation, Rural & Misc.

TABLE 2-8

SPMWD TREATED WATER USE (PURCHASED FROM CORPUS CHRISTI) (IN MGD)

1992	Gregory	Odem	Portland	Taft	Reynolds Metals	Others (1)
January	0.183	0.263	1.052	0.585	0.968	0.101
February	0.229	0.311	1.296	0.606	1.140	0.133
March	0.186	0.277	1.168	0.526	1.018	0.117
April	0.206	0.292	1.222	0.551	1.133	0.135
May	0.219	0.310	1.275	0.569	1.186	0.147
June	0.222	0.295	1.354	0.593	1.017	0.143
July	0.262	0.372	1.951	0.752	1.031	0.185
August	0.377	0.393	2.435	0.998	1.213	0.227
September	0.384	0.343	1.913	0.882	1.138	0.182
October	0.251	0.308	1.528	0.753	1.067	0.145
November	0.238	0.306	1.342	0.670	1.164	0.122
December	0.234	0.304	1.318	0.664	1.222	0.136
1992 Average	0.249	0.314	1.488	0.680	1.108	0.148

(1) Water Supply Corp., Rural & Misc.

TABLE 2-8 - Continued

SPMWD TREATED WATER USE (PURCHASED FROM CORPUS CHRISTI)
(IN MGD)

1993	Gregory	Odem	Portland	Taft	Reynolds Metals	Others
January	0.175	0.259	1.100	0.617	1.039	0.110
February	0.212	0.324	1.293	0.753	1.021	0.143
March	0.185	0.267	1.105	0.582	0.965	0.111
April	0.249	0.336	1.400	0.725	1.102	0.148
May	0.203	0.273	1.186	0.618	1.042	0.118
June	0.235	0.297	1.316	0.691	1.239	0.130
July	0.267	0.357	1.830	0.821	1.201	0.184
August	0.285	0.467	2.556	1.040	1.068	0.258
September	0.240	0.385	1.870	0.843	1.034	0.207
October	0.285	0.335	1.068	0.689	1.026	1.190
November	0.270	0.311	1.357	0.608	1.115	0.143
December	0.266	0.294	1.259	0.545	0.914	0.414
1993 Average	0.240	0.325	1.509	0.711	1.063	0.157

(1) Water Supply Corp., Rural & Misc.

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increased to approximately 22 to 24 mgd by construction of a three million gallon storage reservoir and booster pumping facility, located approximately three miles east-southeast of Odem. For a summary of raw water sold by the SPMWD by customer in 1992 and 1993, see Table 2-9. The SPMWD's total water supply capacity is approximately 31 to 34 mgd (9 to 10 mgd from 24-inch treated water line plus 22 to 24 mgd in 36-inch untreated water line).

2.3.2 Determination of Water Demands

2.3.2.1 District Water Accounting Records

Determination of the municipal and industrial fresh water needs of the area included a review of water accounting records from the SPMWD. The records included the following:

- Treated water sold from the SPMWD Water Treatment Plant to the Cities of Ingleside, Aransas Pass and Rockport; Nueces County Water Control Improvement District #4 (Port Aransas); and Rural Water Supply Corporations and other miscellaneous customers;
- Treated water purchased from City of Corpus Christi and sold to the Cities of Odem, Portland, Gregory and Taft; Reynolds Metals Company; and Rural Water Supply Corporations and other miscellaneous customers; and
- Raw water sold to Reynolds Metals Company, DuPont, Oxychem, and other customers.

The total gallons of water sold per month are tabulated for each customer. The SPMWD has tabulated historical water usage for certain customers over the past 20 to 40 years. Total annual water usage in millions of gallons for the Cities of Aransas Pass, Ingleside, Portland, Gregory, Taft, and Odem are shown graphically along with total annual rainfall recorded at the District Water Treatment Plant (Figures 2-10 through 2-18).

TABLE 2-9

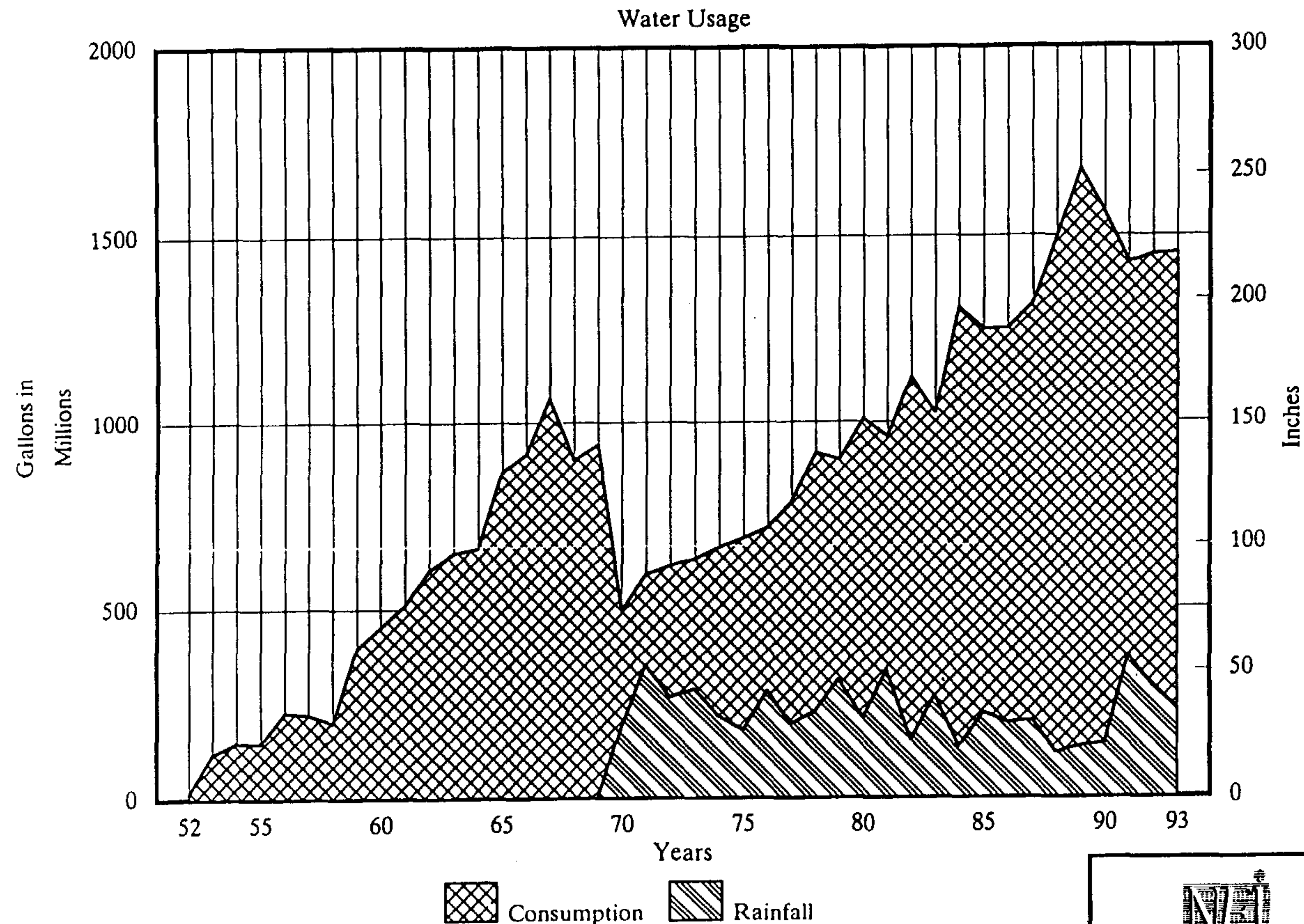
SPMWD RAW WATER SYSTEM - WATER USE BY CUSTOMER (1992 AND 1993)
(MGD)

1992	Reynolds Metals	Du Pont	Oxychem	Other	Raw Water Sold	Plant Treat Sold	Raw Water Use
January	0.234	1.162	2.694	---	4.090	3.251	7.341
February	---	1.389	3.420	---	4.809	3.881	8.690
March	0.891	1.063	3.139	---	5.093	3.366	8.459
April	1.389	1.012	3.359	---	5.760	3.521	9.281
May	0.421	0.956	3.569	---	4.946	4.148	9.094
June	---	1.058	3.583	---	4.641	4.588	9.229
July	2.156	0.930	3.501	---	6.587	6.031	12.618
August	5.904	1.041	3.831	0.069	10.845	6.503	17.348
September	5.183	1.090	3.728	---	10.001	5.754	15.755
October	4.647	1.069	2.884	---	8.600	5.039	13.639
November	3.779	0.720	3.238	---	7.737	4.558	12.295
December	1.560	0.640	3.477	---	5.677	4.254	9.931
1992 Average	2.161	1.011	3.369	0.006	6.566	4.575	11.140

TABLE 2-9, continued

SPMWD RAW WATER SYSTEM - WATER USE BY CUSTOMER (1992 AND 1993)
(MGD)

1993	Reynolds Metals	Du Pont	Oxychem	Other	Raw Water Sold	Plant Treat Sold	Raw Water Use
January	2.726	0.593	2.956	---	6.275	3.666	9.941
February	1.921	1.062	3.505	---	6.488	4.528	11.016
March	2.041	0.802	3.008	0.008	5.859	3.870	9.729
April	4.835	0.422	3.575	---	8.832	4.586	13.418
May	3.324	0.424	2.947	---	6.695	4.214	10.909
June	1.361	0.645	3.208	0.003	5.217	4.937	10.154
July	1.272	1.028	3.457	---	5.757	6.409	12.166
August	5.163	0.777	3.752	0.009	9.701	7.029	16.730
September	5.008	1.047	3.631	0.004	9.689	5.971	15.660
October	4.630	1.005	3.428	---	9.044	5.557	14.601
November	4.399	0.500	3.425	---	8.326	5.120	13.446
December	3.752	0.575	3.130	---	7.458	4.429	11.887
1993 Average	3.375	0.738	3.332	0.003	7.432	5.029	12.461



NOTE: FIGURE REPRINTED BY PERMISSION OF SAN PATRICIO MUNICIPAL WATER DISTRICT.

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NORTHSHORE PLANNING STUDY

SPMWD WATER USAGE
CORPUS CHRISTI TREATED WATER

FIGURE 2 - 10

Drawn By: T.L	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.:	Sheet
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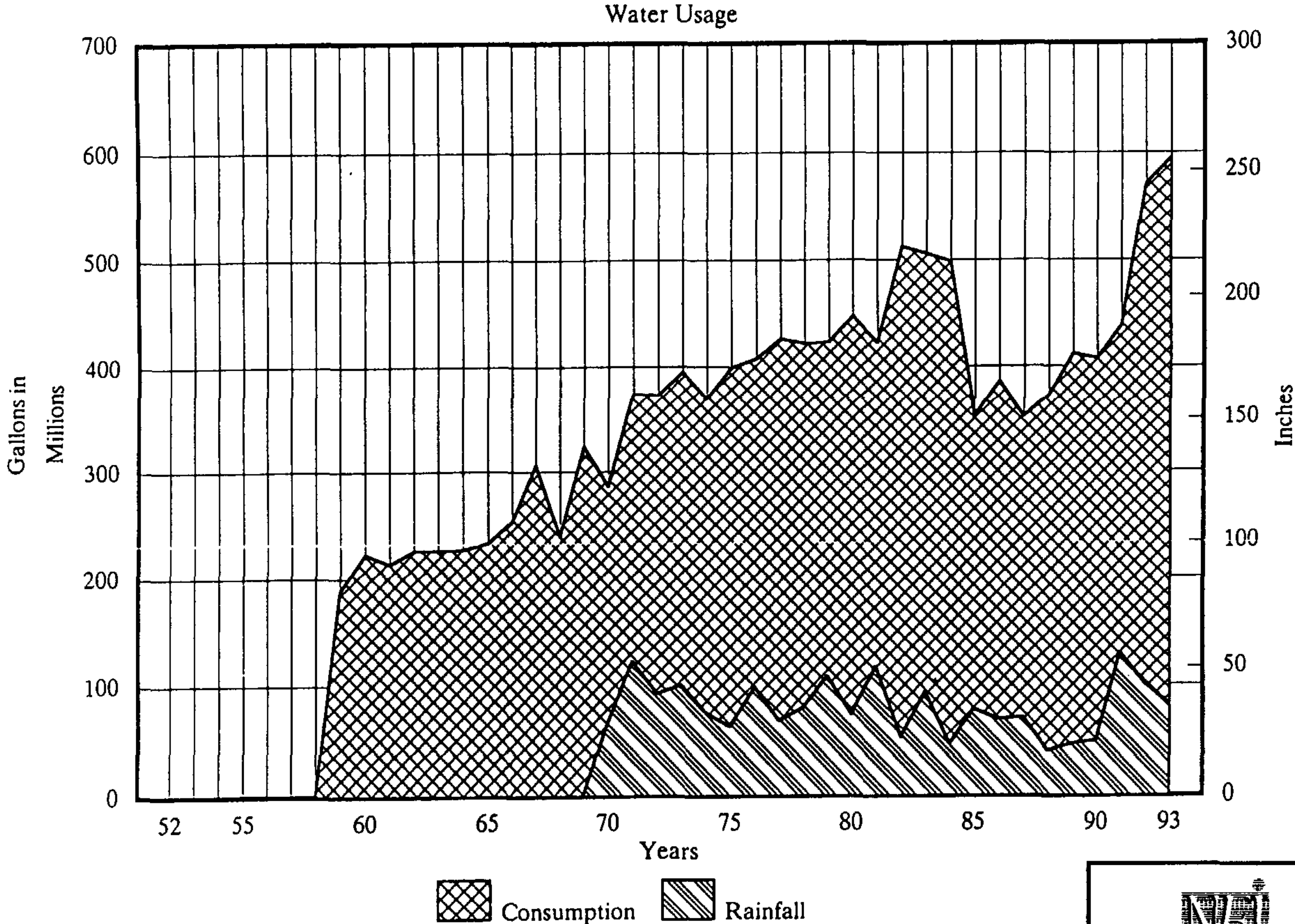

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SPMWD WATER USAGE
ARANSAS PASS TREATED WATER

FIGURE 2 - 11

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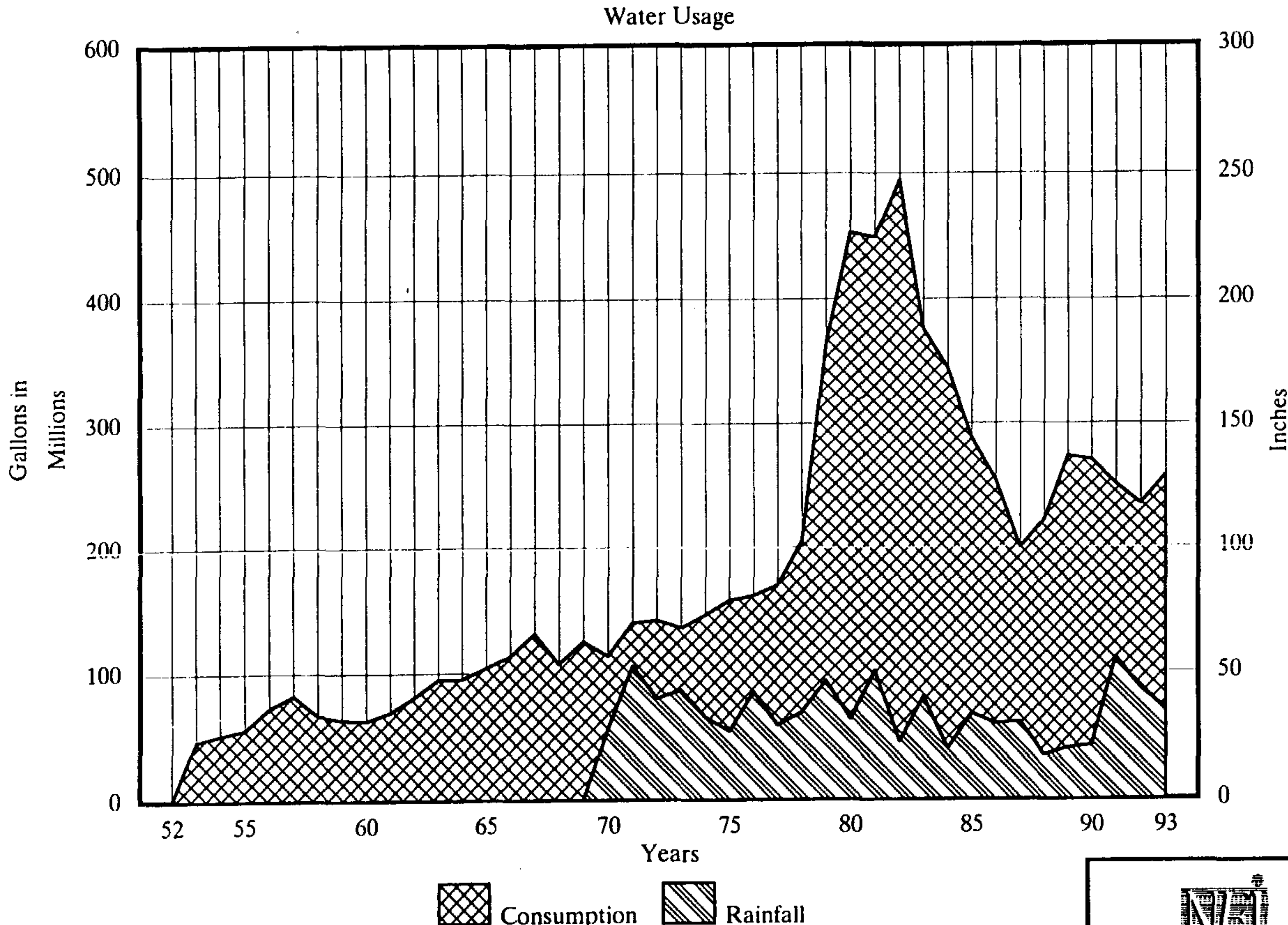

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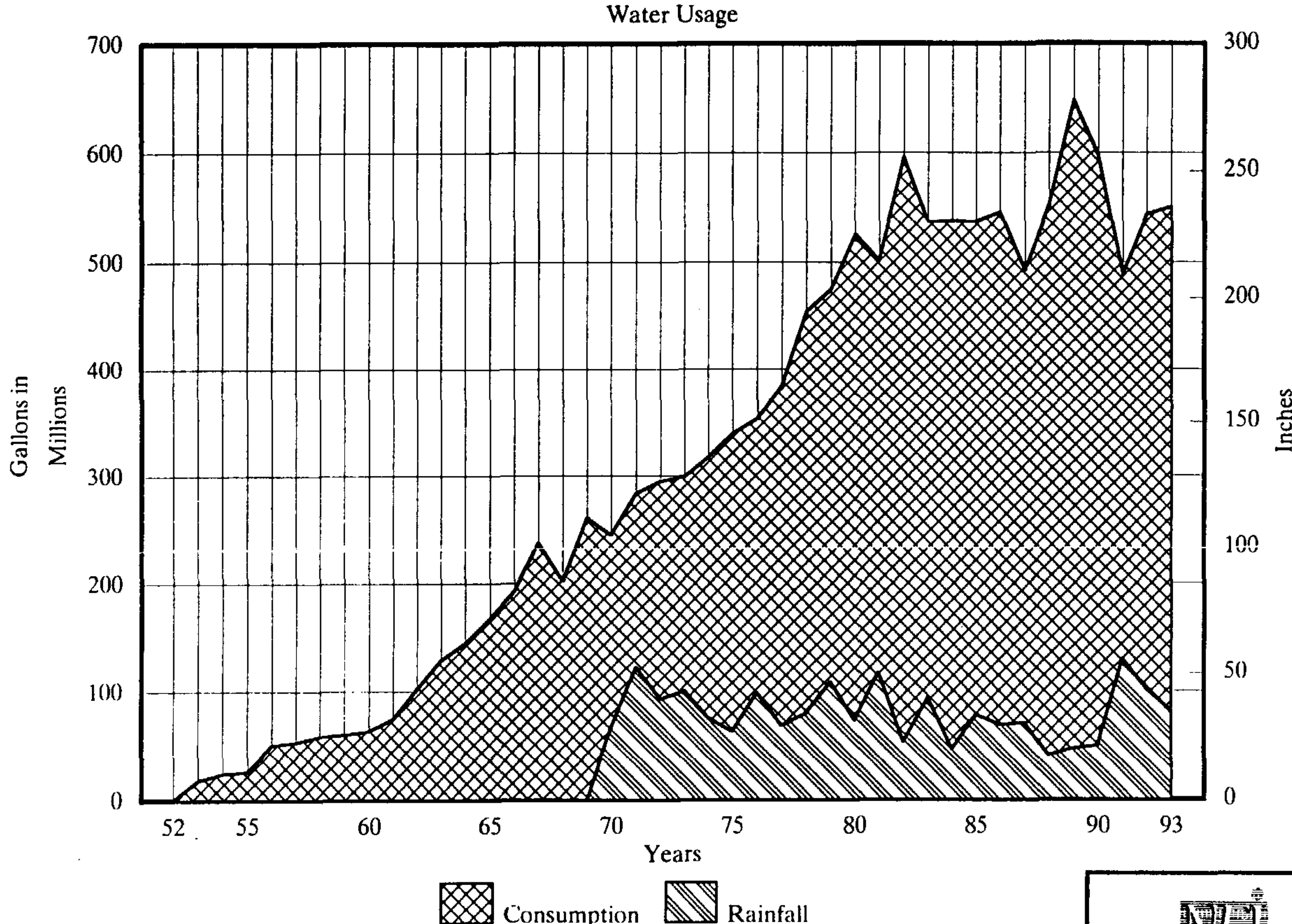
SPMWD WATER USAGE INGLESIDE TREATED WATER

FIGURE 2 - 12

T.L	G. BRIDGES	AS NOTED	
G. BRIDGES	3745	5/94	



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SPMWD WATER USAGE
PORTLAND TREATED WATER

FIGURE 2 - 13

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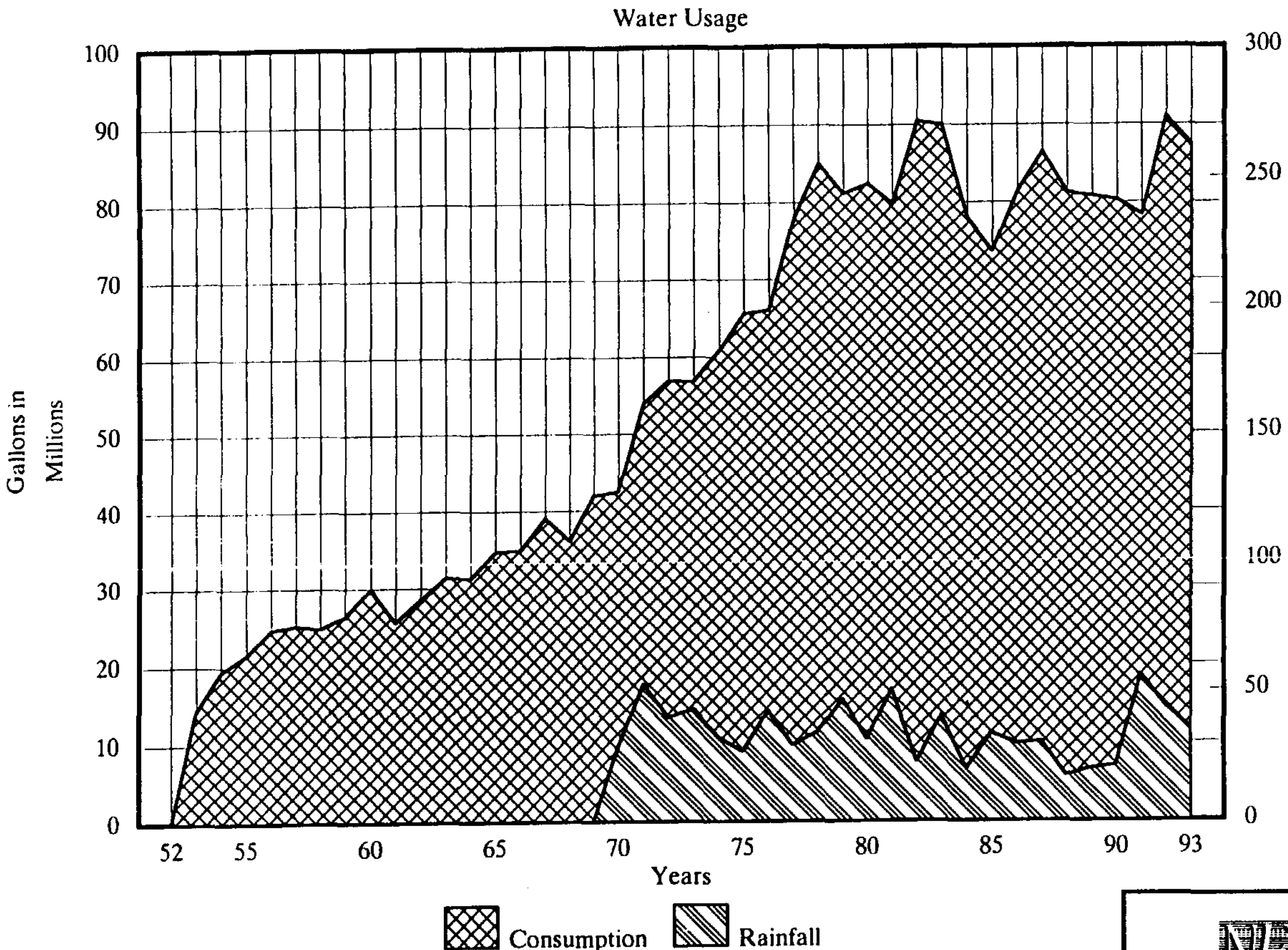

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SPMWD WATER USAGE GREGORY TREATED WATER

FIGURE 2 - 14

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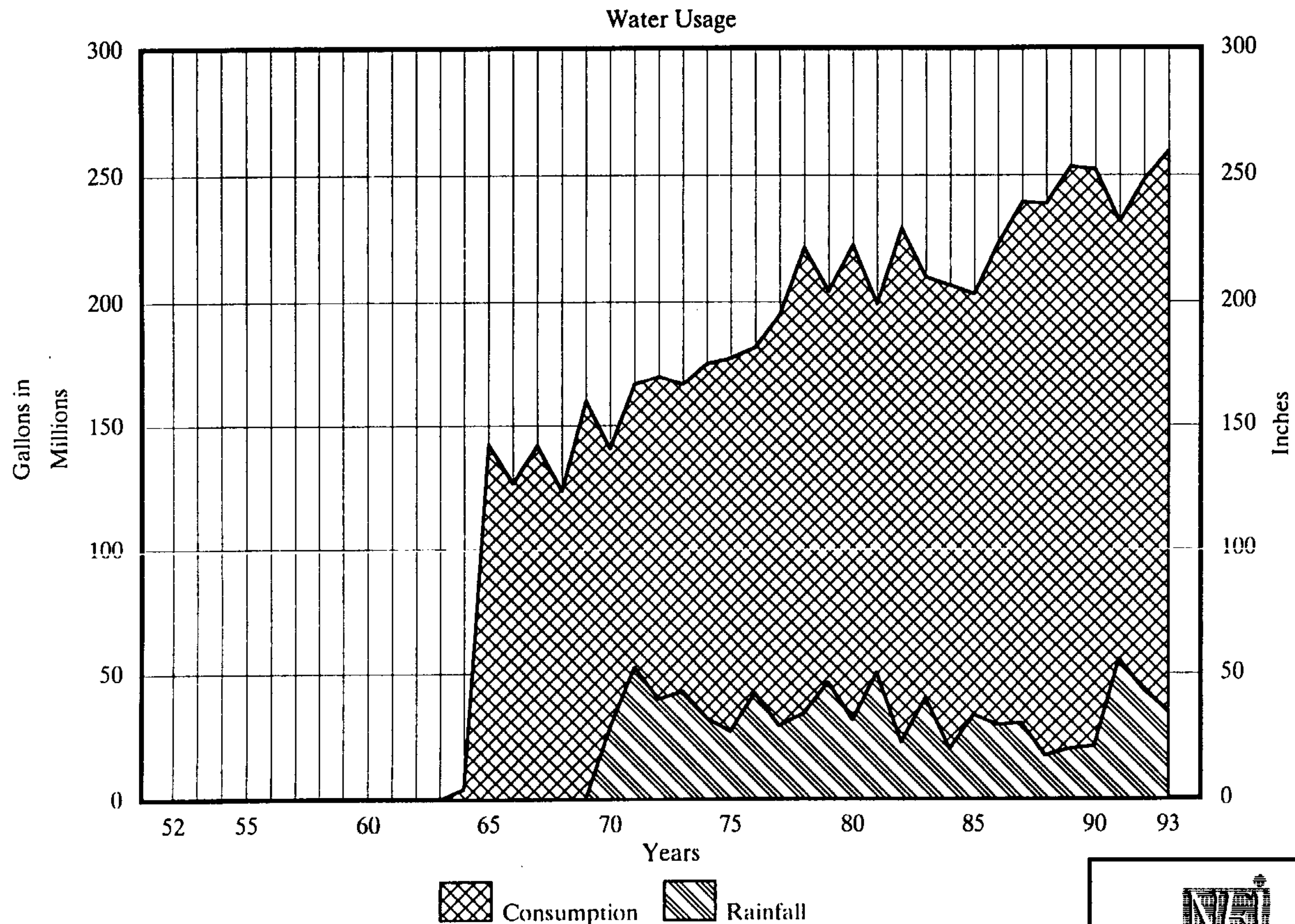

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SPMWD WATER USAGE
TAFT TREATED WATER

FIGURE 2 - 15

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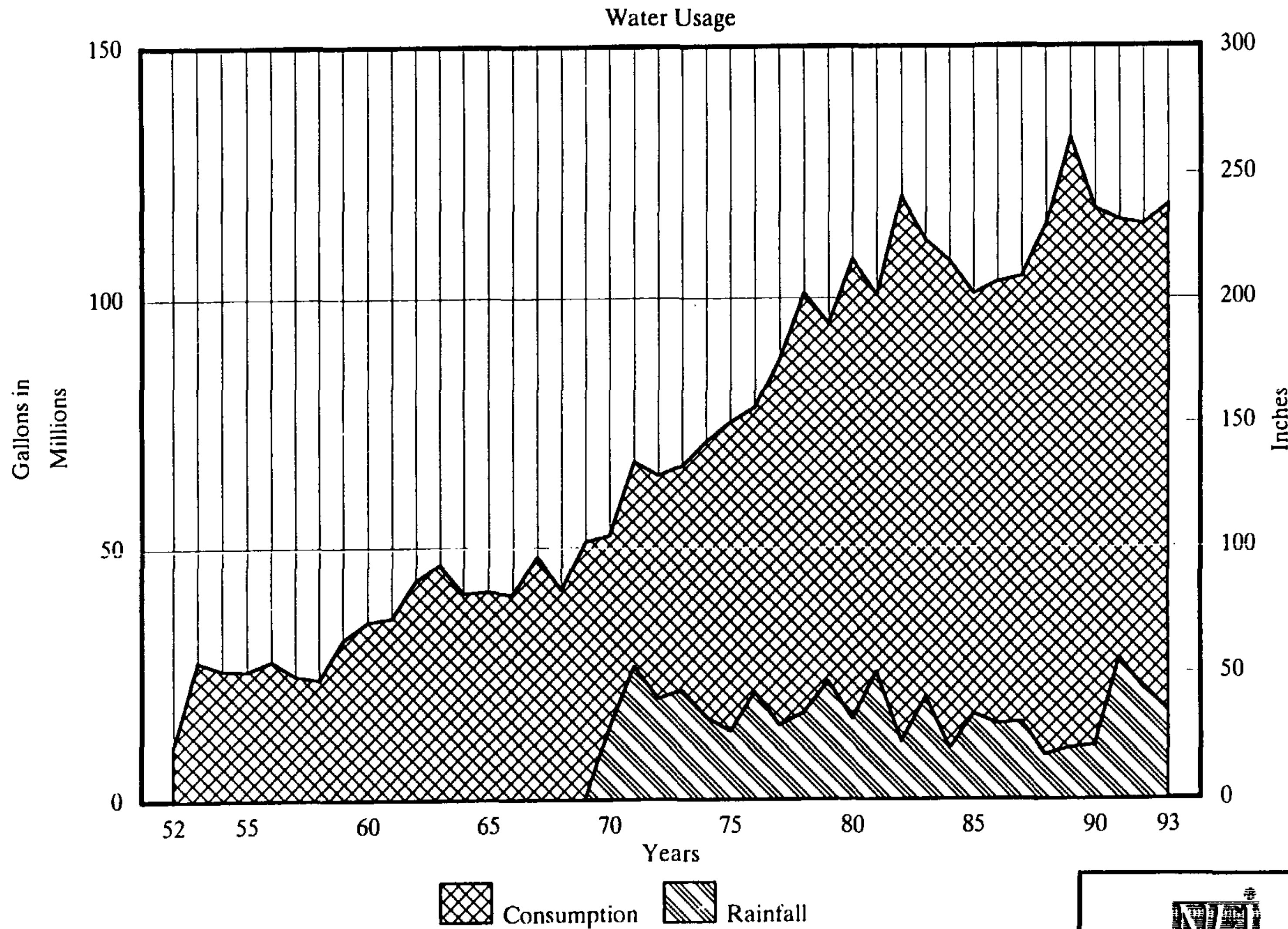

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SPMWD WATER USAGE ODEM TREATED WATER

FIGURE 2 - 16

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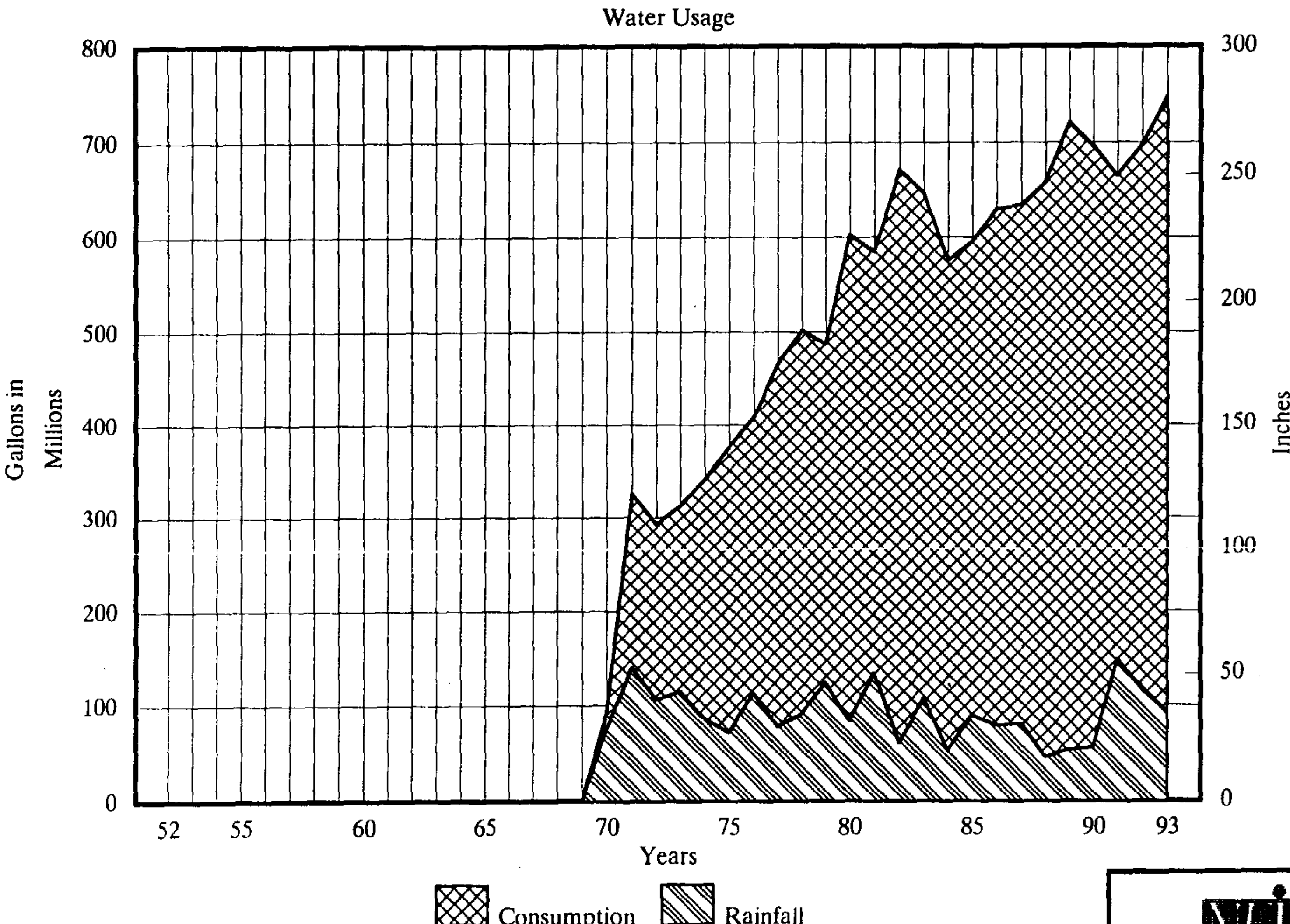

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SPMWD WATER USAGE
ROCKPORT TREATED WATER

FIGURE 2 - 17

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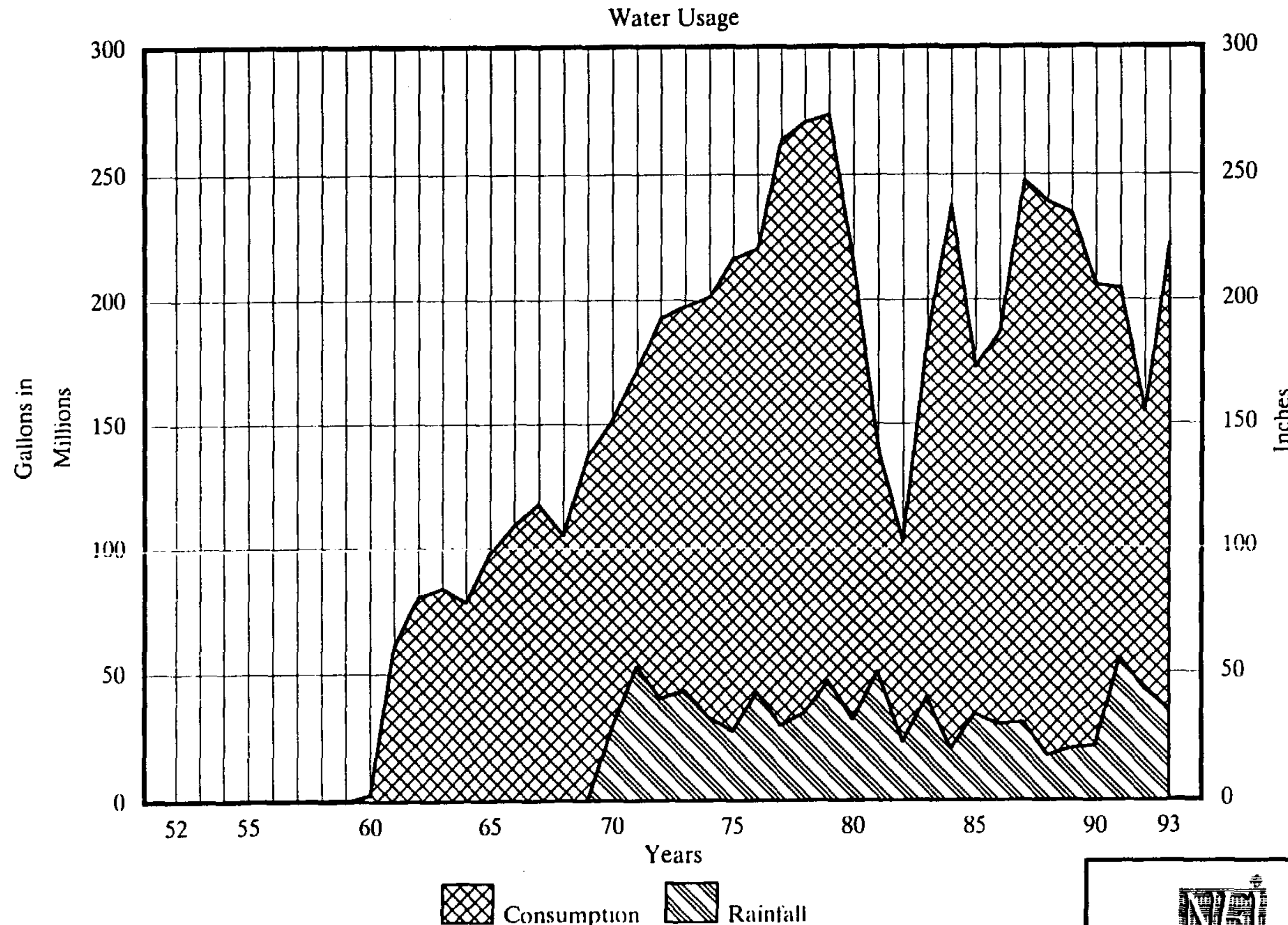

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SPMWD WATER USAGE
PORT ARANSAS TREATED WATER

FIGURE 2 - 18

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2.3.2.2 Freshwater Demand Projections

Factors that affect the use of water include population growth, rainfall and types of development. Population growth in the customer cities has resulted in a steady increase in water demands. The rate of increase has fluctuated over a period of time, depending upon economic conditions. For example, the rate of increase during the 1970's was generally much greater than during the 1980's, when an economic slowdown occurred in the area.

The water use data show a correlation between rainfall and water usage. For example, water usage in Portland during years with relatively lower rainfall totals (1988 - 1990) was substantially higher than the following years, which recorded above average rainfall (Figure 2-15).

Types of development (i.e., the mix of residential, commercial and industrial development in an area) also have an effect upon water usage. For example, the City of Ingleside experienced a significant increase in water usage during the period from 1978 through 1982. This was due to the growth of several industries in the area, primarily independent oil refining operations and offshore service facilities, which were operated for a short period of time and then closed. Water demand for the following years (1982 - 1987) showed a steady decline with this lowering of industrial demand. However, if this peak is disregarded, a relatively constant increase in water usage for the period from 1952 through 1993 is evident (Figure 2-12). Major facilities, such as Homeport, would also be expected to generate increases in water usage from new commercial, residential and industrial developments that are constructed to support the complex.

Water demands were projected for scenarios of lower than average and above average rainfall, using population data and water accounting records over the past five years to determine per capita use factors (gpcd) (Table 2-10). Data from 1990 were used to determine gpcd factors for lower than average rainfall conditions. This is due to the fact that rainfall recorded at the plant during the two-year period from 1988 to 1990 was lower than for any period since rainfall data have been recorded. Similarly, the two-year period from 1991 to 1993 recorded rainfall totals as high as any other consecutive period. Therefore, data from 1992 were used to determine gpcd factors for above average rainfall conditions. Average gpcd factors for 1990 and 1992 were then used, with the population projections presented in Section 2.1.3.1 to project future water usage in the SPMWD's customer cities for the years 2000, 2010, and 2020 (Table 2-11).

2.3.2.3 Existing Water Supply Capacity Compared to Projected Demands

The SPMWD's historical treated water peak demand was determined by a review of meter readings for a two or three day average during peak months in 1991, 1992 and 1993. The average of the peak month in each of the three years is shown in Table 2-12.

Figure 2-19 shows a projection of the future municipal water demand during the peak month, based on data from Tables 2-11 and 2-12. It is observed from Figure 2-19 that the total treated water demand during the peak month (municipal and Reynolds Metals Co.) will exceed the SPMWD's treated water supply capacity (assuming the booster station is not in operation) in approximately the year 2000.

TABLE 2-10

SUMMARY OF AVERAGE WATER USAGE AND PER CAPITA WATER USAGE (1990 AND 1992)

City	1990			1992			1990 & 1992 Average Per Capita Water Use (GPCD)
	Population Estimate	Average Daily Water Use (MGD)	Per Capita Water Use (GPCD)	Population Estimate	Average Daily Water Use (MGD)	Per Capita Water Use (GPCD)	
Aransas Pass	7180	1.117	156	7418	1.567	211	184
Gregory	2458	0.220	90	2652	0.249	94	92
Ingleside	5696	0.741	130	6020	0.643	107	119
Odem	2366	0.323	137	2392	0.314	131	134
Portland	12224	1.637	134	12577	1.488	118	126
Taft	5234	0.691	132	5411	0.680	126	129

TABLE 2-11
PROJECTED AVERAGE DAILY MUNICIPAL WATER DEMAND

Study Area	Year	Projected Population	Per Capita Water Use (GPCP) Actual Value	Per Capita Water Use (GPCP) Recommended Planning Value	Average Daily Water Use (MGD) Actual Value	Average Daily Water Use (MGD) Recommended Planning Value
Aransas Pass	1990	7180	184	184	1.32	**1.32**
	2000	8129			1.50	**1.50**
	2010	9293			1.71	**1.71**
	2020	10634			1.96	**1.96**
Gregory	1990	2458	92	110	-	**0.27**
	2000	3233			-	**0.36**
	2010	4110			-	**0.45**
	2020	4774			-	**0.52**
Ingleside	1990	5695	119	119	0.68	**0.68**
	2000	6993			0.83	**0.83**
	2010	8275			0.98	**0.98**
	2020	9432			1.12	**1.12**
Ingleside on the Bay	1990	580	130	130	0.08	**0.08**
	2000	684			0.09	**0.09**
	2010	1000			0.13	**0.13**
	2020	1000			0.13	**0.13**
Odem	1990	2366	134	134	0.32	**0.32**
	2000	2467			0.33	**0.33**
	2010	2816			0.38	**0.38**
	2020	3215			0.43	**0.43**
Portland	1990	12224	126	126	1.54	**1.54**
	2000	13636			1.72	**1.72**
	2010	15156			1.91	**1.91**
	2020	16523			2.08	**2.08**
Sinton	1990	5549	-	110	-	**0.61**
	2000	6265			-	**0.69**
	2010	7154			-	**0.79**
	2020	8168			-	**0.90**
Taft	1990	5245	129	129	0.68	**0.68**
	2000	5937			0.77	**0.77**
	2010	6345			0.82	**0.82**
	2020	6712			0.87	**0.87**
Port Aransas	1990	2233	-	110	-	**0.25**
	2000	2485			-	**0.27**
	2010	2707			-	**0.30**
	2020	3116			-	**0.34**
Rockport	1990	4753	-	110	-	**0.52**
	2000	5857			-	**0.64**
	2010	7148			-	**0.79**
	2020	8517			-	**0.94**
Rural Water Supply Corporations & Misc.	1990	-	-	-	-	**0.20**
	2000					**0.24**
	2010					**0.29**
	2020					**0.35**

SUMMARY OF ALL MUNICIPAL DEMANDS

Year	Population	Total Average Daily Water Demand (mgd)
1990	48283	6.47
2000	55686	7.44
2010	64004	8.55
2020	72091	9.64

TABLE 2-12

TREATED WATER DEMAND DURING PEAK MONTH
(AVERAGE OF PEAK MONTHS DURING 1991, 1992, AND 1993)

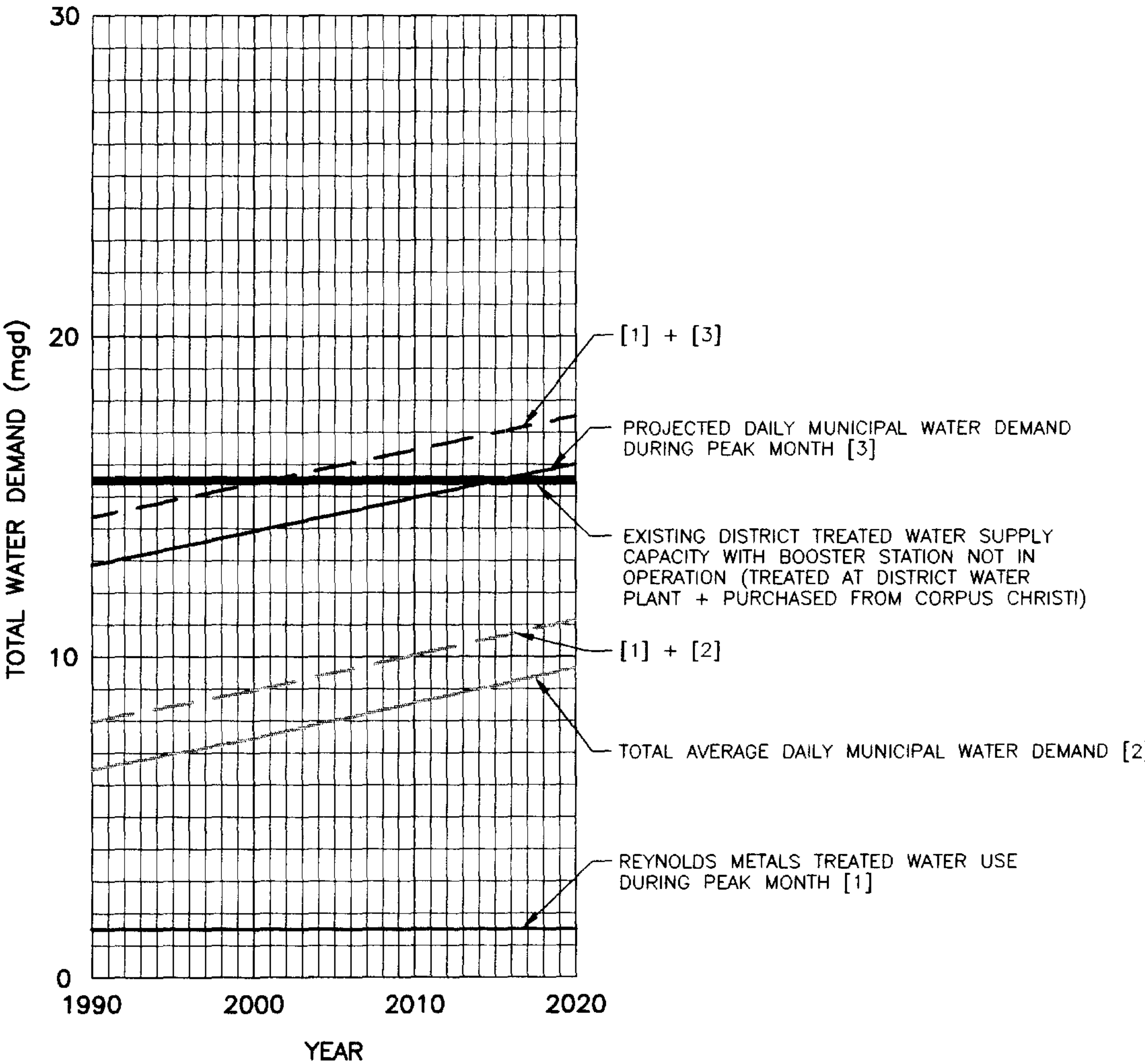
Customer	Peak Demand (mgd)
Ingleside	1.11
Aransas Pass	2.23
Port Aransas	1.40
Rockport	3.42
Portland	2.80
Gregory	0.52
Odem	0.53
Taft	1.13
Total (Municipal)	13.14
Reynolds Metals Co.	1.45
Total (Municipal and Reynolds)	14.59

The SPMWD has contractual obligations with area industries to supply the following quantities of water:

Reynolds Metal Company	6.0 mgd (with provisions for up to 9.0 mgd for short periods of time).
DuPont	4.8 mgd
Oxychem	5.7 mgd
TOTAL	16.5 mgd

The SPMWD's contracts with cities and other domestic users do not generally include specific amounts, but state that water will be provided to meet the needs of the customer.

The projected daily municipal demands during the peak month and the existing water supply contracts with industries are shown graphically in Figure 2-20. The SPMWD's existing untreated and treated water supply capacity (approximately 31 to 34 mgd as stated in Section 2.3.1.2) is also graphed. It is observed from Figure 2-20 that the SPMWD's existing total water supply capacity is only slightly greater than the sum of the projected daily municipal water



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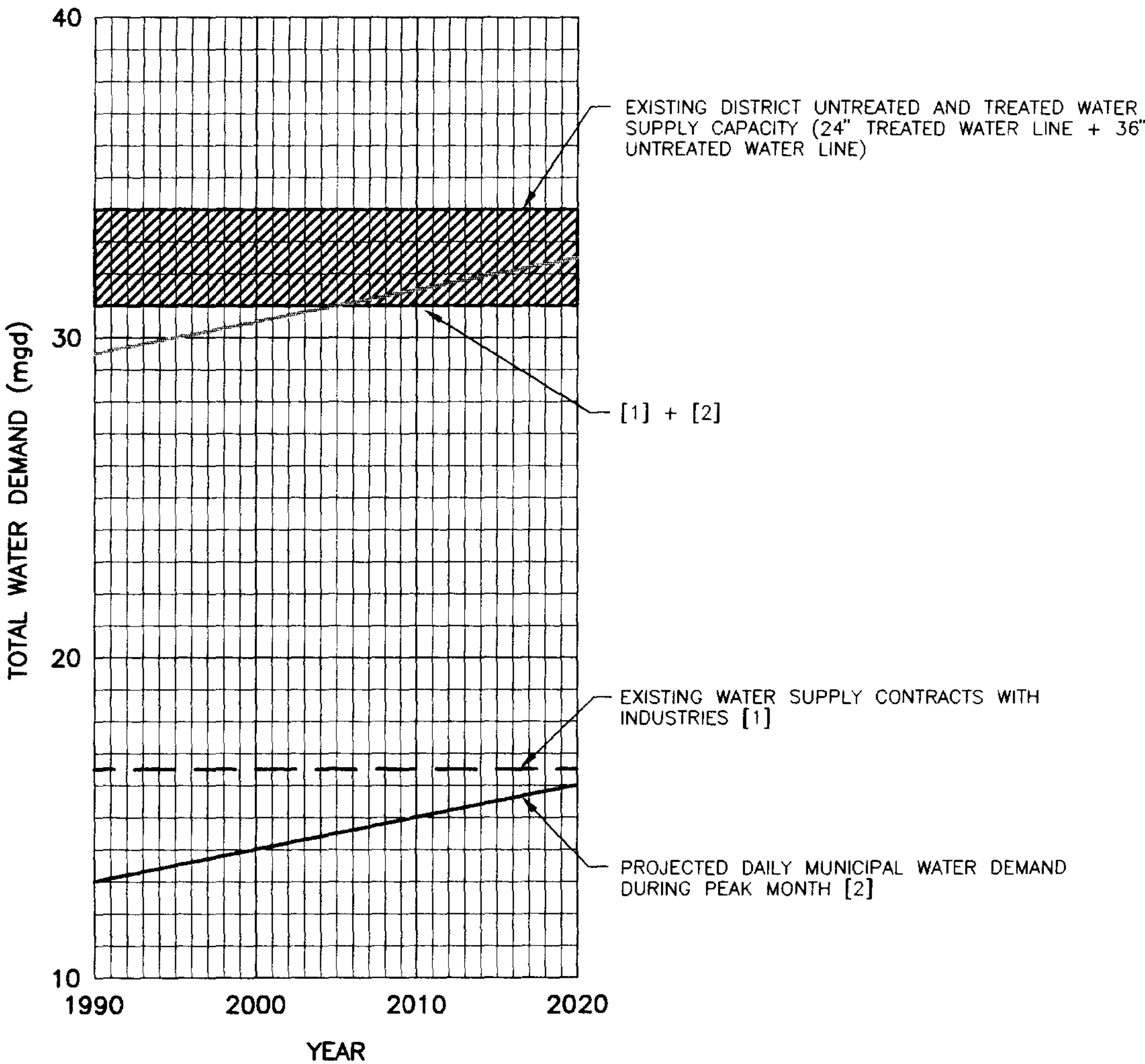
PLOT OF EXISTING TREATED WATER SUPPLY CAPACITY AND PROJECTED TREATED WATER DEMAND

FIGURE 2 - 19

Drawn By: E. BUSSEY	App. By: G. BRIDGES	Scale: 1" = 1"	Dwg. NO.: 3745-WD1	Sheet 1
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of 1



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PLOT OF EXISTING TOTAL WATER SUPPLY CAPACITY
AND PROJECTED TOTAL WATER DEMAND
(TREATED AND UNTREATED)

FIGURE 2 - 20

Drawn By: A.NORIEGA	Appr. By: G. BRIDGES	Scale: 1" = 1"	Dwg. No.: 3745-WD2	Sheet 1
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of 1

demand during the peak month plus the existing water supply contracts with industries. Therefore, the existing system will accommodate only a small amount of additional demand.

2.4 Evaluation of Innovative Solutions for Reuse

2.4.1 Current Fresh Water Demands to be Satisfied through Effluent Reuse

TNRCC regulations for wastewater plant discharge permits require that the permittee, within one year of permit issuance, submit a study that investigates the possibility of substituting reclaimed water for potable water and/or fresh water where such substitution would be both appropriate and cost effective (Chapter 31 TAC Section 305.126 (b)).

Existing uses of reclaimed water in the study area are summarized below:

- Aransas Pass - In the past, the City has used effluent at its WWTP for yard irrigation, washdown and chlorine solution make-up water, but is currently not doing so. The City is currently in the process of making application for renewal of its discharge permit and amending it to allow effluent to be used for irrigation at a City-owned park, located west of the Municipal Airport runway and on the Southeast side of Arch Street. Approximately 96,000 gallons/day will be used for irrigation of the park.

- Ingleside - The City currently uses effluent for chlorine solution make-up water and in the washdown loop at its WWTP. In addition, the City has the capability of using effluent for irrigation of yard areas within the plant site.

- Gregory - The City does not currently use effluent for any purpose.

- Sinton - The City does not currently use effluent for any purpose.

- Odem - The City does not currently use effluent for any purpose.

- Portland - The City currently has the capability to use effluent for irrigation of yard areas at the Main WWTP. Effluent is not currently used for any other purpose within the City. Irrigation of school and park sites is through the use of potable water.

- Taft - The City currently uses effluent for chlorine solution make-up water, plant washdown water and yard irrigation at the WWTP (during drought periods). In addition, the City has a permit for irrigation of a grass farm. The farming operation occurred during the period from 1983-1992, but is presently inactive. The City has conducted a benefit-cost analysis for using effluent to irrigate parks and cemetery sites. The analysis showed that use of effluent at City parks and the cemetery is not cost effective at this time.

An inventory of additional potential uses of reclaimed water in the study area includes the following:

- Irrigation of agricultural cropland.
- Irrigation of unrestricted landscape areas, such as City and County parks, school sites and sports complexes.
- WWTP uses, such as make-up water for chlorine solution, washwater for cleaning plant facilities and irrigation of yard areas within the site.
- Industrial use.
- Irrigation of restricted landscape areas, such as golf courses, cemeteries, road right-of-ways and median dividers.

No additional agricultural cropland irrigation demands were identified through inquiries conducted during this study. All cities in the study area have the potential for use of effluent for irrigation of unrestricted landscape areas. However, TNRCC regulations will require plant upgrades to meet effluent limitations and certain projects may not prove to be cost effective through a benefit-cost analysis. Three Cities (Gregory, Sinton and Odem) have the potential for using effluent in small amounts at their WWTP sites. However, the cost of reuse facilities may not justify the benefit derived.

Two major fresh water demands in the study area that may be satisfied by effluent reuse were identified during the study and are as follows: (1) irrigation of restricted landscape areas at the Northshore Country Club Golf Course, and (2) industrial use at the Reynolds Metals Plant. These demands are further discussed in the following sections.

2.4.1.1 North Shore Country Club

2.4.1.1.1 Background

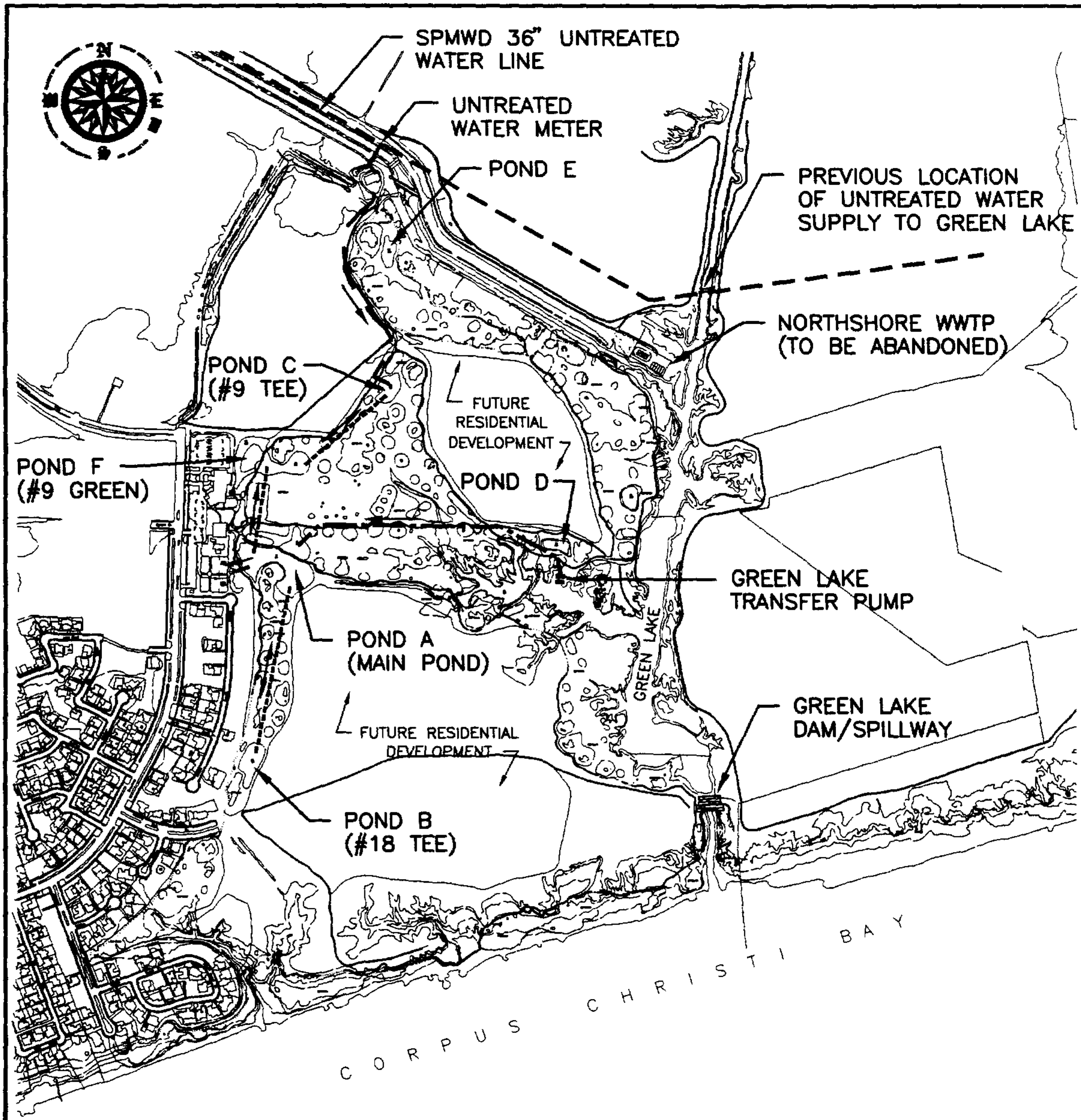
The North Shore Country Club (NSCC) is part of the overall North Shore Development located west of Green Lake in the eastern portion of the City of Portland. The NSCC includes an 18-hole golf course and other recreational facilities. North Shore Associates, original owners and operators of the country club, secured a water rights permit from the Texas Water Commission (now Texas Water Resource Conservation Commission (TNRCC)) for Green Lake on June 10, 1985. The permit allows NSCC to withdraw up to 557 acre-feet per year (0.50 mgd) for the purposes of irrigating approximately 185 acres of land consisting of the golf course and common landscaped areas within the residential development.

The permit also authorized the construction of six off-channel reservoirs in order to impound water diverted from Green Lake. Withdrawal rate from Green Lake is limited to 3.1 cfs (2.0 mgd).

2.4.1.1.2 Irrigation Supply Facilities

A diesel-powered transfer pump and intake diverts water from the Golf Course Arm of Green Lake to the Main Pond, located just east of the clubhouse. This pond is interconnected with the 9-Tee Pond, the 9-Green Pond, and the 18-Tee Pond to provide approximately 43 acre-feet of on-site storage volume for the NSCC irrigation system (Figure 2-21).

To provide a back-up supply when water level or quality in Green Lake is insufficient for making withdrawals, NSCC has an agreement with the City of Portland (COP) to purchase raw water on an as-needed basis. This water is obtained through a tap in the San Patricio County Municipal Water District (SPMWD) raw water pipeline which runs east-west north of the NSCC. A buried pipeline diverts raw water from the pipeline directly to NSCC's 9-Tee pond.



LEGEND

(dotted line)	GOLF COURSE IRRIGATION POND INTERCONNECTION LINE
(dash-dot line)	GREEN LAKE IRRIGATION WATER SUPPLY LINE
(solid line)	IRRIGATION PUMP STATION SUCTION LINE
(long-dash line)	UNTREATED WATER SUPPLY LINE

GRAPHIC SCALE IN FEET

1000 500 0 1000 2000

HORIZONTAL

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NORTHSHORE COUNTRY CLUB IRRIGATION SYSTEM

FIGURE 2 - 21

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2.4.1.1.3 Irrigation Water Usage

On an average annual basis, NSCC's irrigation water demand is 226 acre-feet, with approximately 175 acre-feet withdrawn from Green Lake and 51 acre-feet purchased from the City of Portland (Table 2-13). In five of the previous nine years, Green Lake was inadequate to meet NSCC's irrigation needs.

Although NSCC has a water rights permit for Green Lake allowing them to withdraw up to 557 acre-feet of water annually, the firm, or dependable, yield of Green Lake is far less than this amount. The RESOP computer model was used to calculate the firm yield of Green Lake under several conditions. RESOP uses annual inflows, net annual evaporation, and a specified demand distribution of determine the volume of water that can be dependably withdrawn from a reservoir on an annual basis. Examination of water use records for NSCC over the period 1985 through 1993 indicates that NSCC's irrigation demands vary over the course of the year according to the distribution in Table 2-14.

2.4.1.1.4 Irrigation Water Quality

The primary water quality consideration for irrigation of the NSCC golf course is the concentration of chlorides. The subsurface water table in the area is relatively shallow (8 to 10 feet below ground surface). Because of the close proximity to the marine environment, ground water in the area is moderately saline to strongly saline. There is a well known saline to brackish groundwater halo that parallels the coastline principally affecting the shallow horizons several miles inland. The fresh water near the surface of Green Lake is lighter than the more saline subsurface water and forms a fresh water layer above the underlying salt water. A drawdown of the fresh water layer corresponds to a significant increase in salinity of Green Lake. In addition, evaporation tends to concentrate the chlorides in the lake. NSCC has

TABLE 2-13
NSCC HISTORICAL IRRIGATION WATER USE (ACRE-FEET) 1985-1993

Year	From Green Lake	From Portland	Total
1985	222.00	0.00	222.00
1986	92.26	158.14	250.40
1987	224.54	0.00	224.54
1988	232.06	0.00	232.06
1989	39.35	175.12	214.47
1990	146.43	87.79	234.22
1991	186.40	0.00	186.40
1992	168.80	0.02	168.82
1993	162.27	44.15	206.42
Average	174.61	51.69	226.30

TABLE 2-14
IRRIGATION DEMAND DISTRIBUTION FOR NSCC

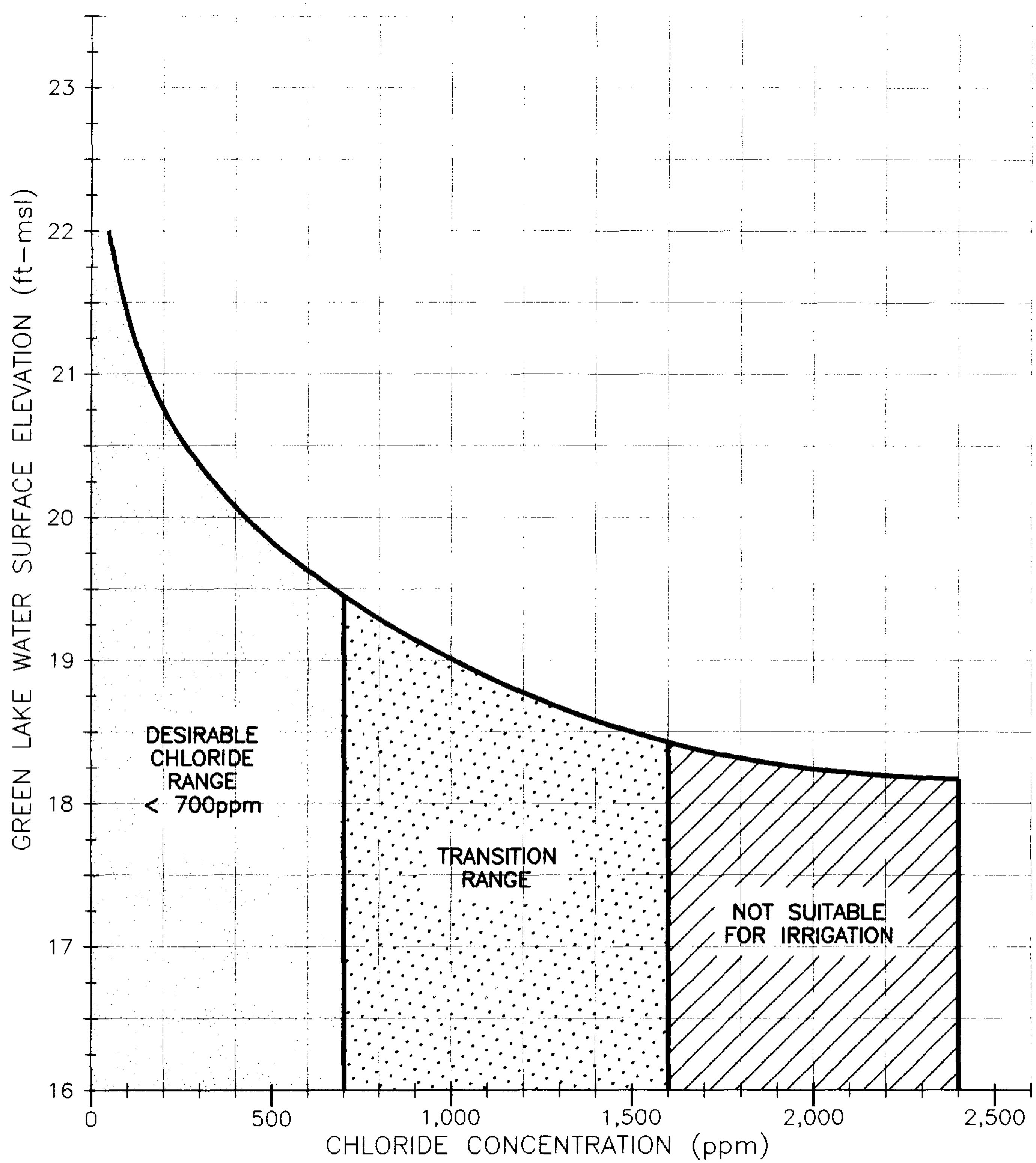
Month	Percent of Total Annual Use
January	3
February	3
March	6
April	7
May	7
June	11
July	15
August	15
September	11
October	11
November	6
December	5
Total	100 %

conducted routine water quality sampling to insure that chloride concentrations of water used for irrigation are in an acceptable range. Representative results of past chloride concentration tests in Green Lake are shown graphically in Figure 2-22. It is observed that water surface elevations above approximately 19.5 feet-msl are required to maintain desirable chloride concentrations below 700 ppm. Chloride concentrations corresponding to water surface elevations lower than approximately 18.5 feet-msl have not proven to be suitable for sustained irrigation during drought periods. A water elevation of approximately 17.5 feet-msl was measured during the summer of 1993.

Typically, Green Lake has a seasonal fluctuation in water elevation. In years with average or less than average rainfall, the water elevation drops as much as 4 to 5 feet below the outfall spillway elevation of 20.5 feet-msl during the late summer and early fall months. NSCC monitors the elevation and corresponding chloride concentration to insure that the water is suitable for irrigation.

2.4.1.1.5 Alternatives for Satisfying NSCC's Irrigation Water Demand

Green Lake yields should be based on active storage above approximate elevation 18.0 feet-msl because the volume of water contained in the lake below elevation 18.0 feet msl is essentially dead storage; because of excessive turbidity and high salinity, this water is not suitable for irrigation. In addition, due to the vegetative overgrowth and arrangement of the pump suction line, it is doubtful that NSCC's existing intake facilities are capable of efficiently withdrawing water below elevation 18.0. In practical terms, the firm yield of Green Lake is zero (Table 2-15). Only when considering effluent inflows from Gregory's wastewater treatment plant does Green Lake develop a significant yield and then only one which is well under NSCC's average annual demand as well as their permitted right.



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PLOT OF GREEN LAKE CHLORIDE CONCENTRATION BASED ON WATER ELEVATION

FIGURE 2 - 22

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: NONE	Dwg. NO.: 3745-CH2	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev	of

Table 2-15
Firm Yield of Green Lake

Condition	Yield (ac-ft/yr)
Natural inflows No WWTP effluent inflow Active storage = el. 14.0' to 20.6' (all)	55
Natural inflows Gregory WWTP effluent inflow (=.18 mgd) Active storage = el. 14.0' to 20.6' (all)	242
Natural inflows No WWTP effluent inflow Active storage = el. 18.0' to 20.6'	0
Natural inflows Gregory WWTP effluent inflow (=.18 mgd) Active storage = el. 18.0' to 20.6'	135

Due to the seasonal drop of water elevation and increase in chlorides, NSCC has found it necessary to supplement the water in Green Lake by purchasing raw water from the San Patricio County Municipal Water District (SPMWD) through the City of Portland (COP). Prior to 1992, raw water was discharged into Green Lake through a temporary meter installed on the 36-inch diameter untreated water supply main at it aerial crossing of Green Lake upstream from the NSCC intake. Due to the inefficiencies involved with this supply method, a permanent meter was installed on the 36-inch main near the golf course maintenance facility and a 12-inch diameter line was extended to discharge into the 9-Tee Pond (Figure 2-21).

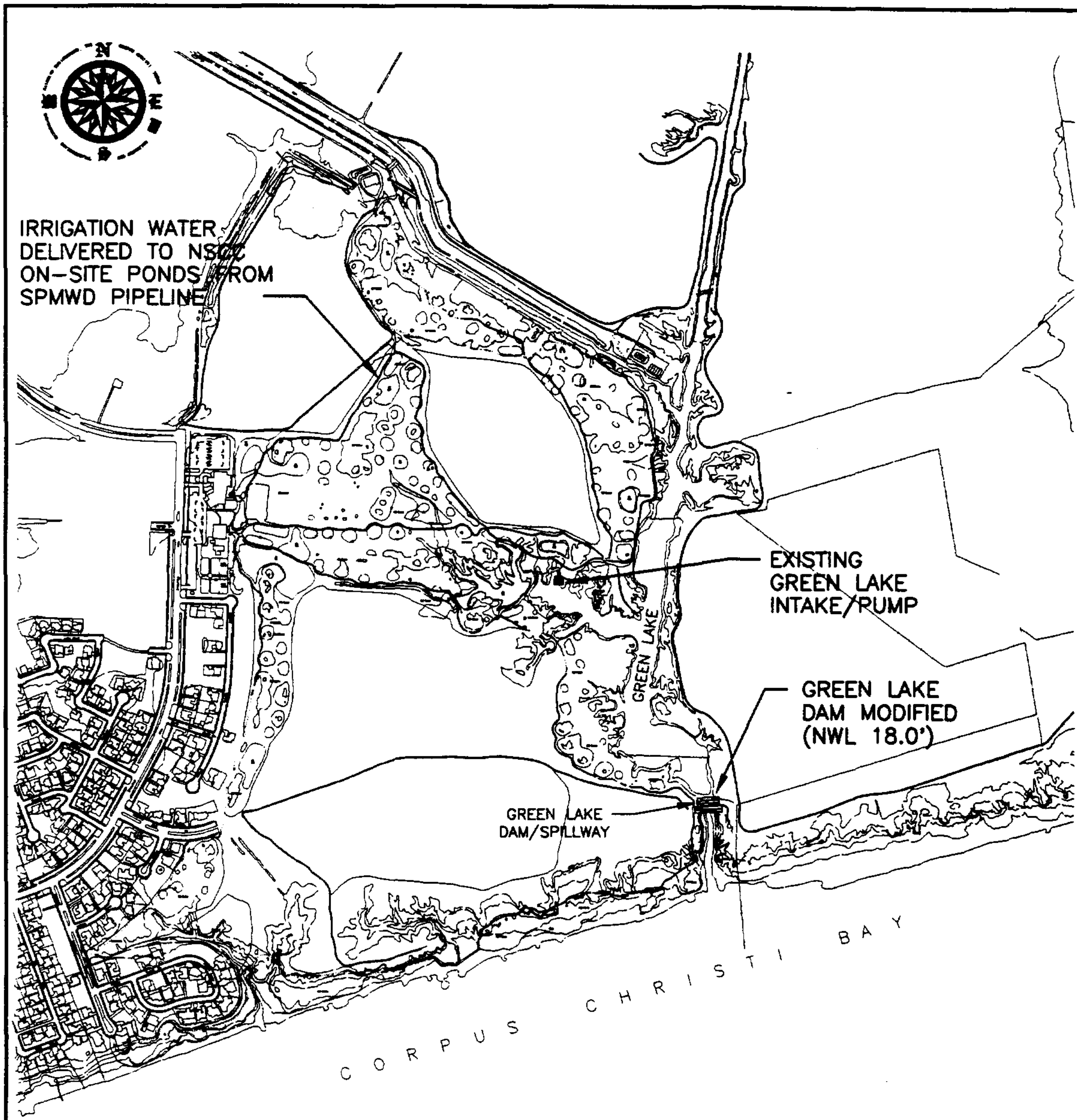
NSCC purchases raw water from the SPMWD (through COP) at a rate of approximately $1.05 per 1,000 gallons. In addition to the purchase of raw water to supplement the Green Lake supply, NSCC has also purchased treated water from the City of Portland system by discharging from a fire hydrant into the Main Pond.

Proposed flood control modifications to Green Lake Dam will reduce the normal pool level to approximate elevation 18.0 feet msl. Because lake water maintained at this elevation is expected to be too saline for irrigation use and because continued withdrawals from the lake below this elevation will have negative aesthetic impacts, it is anticipated that irrigation withdrawals from Green Lake will be discontinued under the proposed Northshore project, except possibly while the lake is in flood stage (i.e., above elevation 18.0 feet msl). In order to continue to satisfy NSCC's irrigation needs, several alternative water delivery scenarios were developed and evaluated. These scenarios are described below.

Scenarios 1A and 1B

Under this alternative, with the Green Lake Dam spillway modified to reduce the normal pool level from elevation 20.6 to 18.0 feet-msl, NSCC would continue to operate as they presently do, with the additional restriction that withdrawals from Green Lake could only occur when the lake is spilling (i.e., pool level above elevation 18.0 feet msl). Remaining irrigation water needs could be met through purchases from the City of Portland in accordance with the current rate schedule, however, NSCC would probably want to attempt to negotiate a new rate; i.e., see Scenario 4, below.

The amount of water available from Green Lake is affected by the rate at which treated wastewater is discharged from the City of Gregory plant. Therefore, two cases were considered: Case "A", where Gregory's treated effluent continues to reach Green Lake (annual discharge in 1993 assumed to be 0.18 mgd) and Case "B", where the discharge of treated effluent from the Gregory plant is discontinued through their participation in a regional plant. Under this scenario, on an average annual basis, NSCC could "scalp" 147 acre-feet per year from Green Lake under Case A and 133 acre-feet per year under Case B. Therefore, NSCC would need to purchase 79 acre-feet of irrigation water per year from the City of Portland under Case A and 93 acre-feet per year under Case B (Figure 2-23). See Section 2.5.6.10 for cost estimates.



GRAPHIC SCALE IN FEET

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HORIZONTAL

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NSCC DELIVERY SCENARIO 1

FIGURE 2 - 23

Drawn By: A. NORIEGA	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-CC2	Sheet
Checked By: C. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:	of

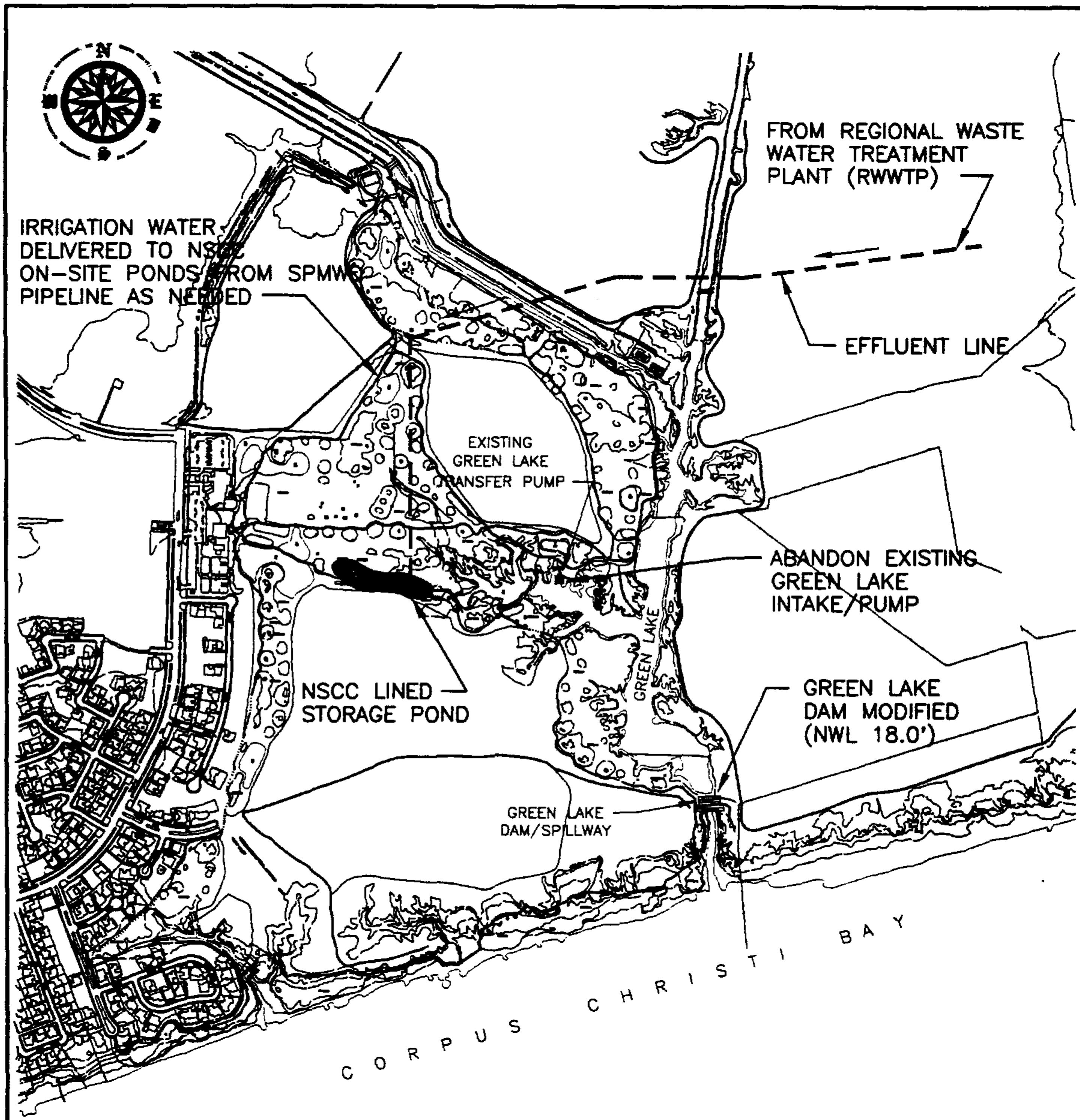
Scenario 2

Under this alternative, NSCC would take secondary-treated effluent from the proposed regional wastewater treatment plant to be located west of Reynolds Metals property. Effluent would be delivered to a new lined holding pond located on NSCC property just east of the existing Main Pond. TNRCC regulations require that effluent of this quality be stored only in lined storage facilities. Under this scenario, NSCC would be responsible for a portion of the cost of the primary plant at the regional facility as well as the entire cost of the secondary treatment plant, pump and pipeline delivery system, and the new lined storage pond. The secondary treatment plant and pump/pipeline system would be sized to deliver 0.5 mgd of effluent to NSCC on an average daily basis with a capability of peaking to 1.0 mgd (Figure 2-24). See Section 2.5.6.10 for cost estimates.

Scenarios 3A and 3B

Under this alternative, an overflow dam would be constructed at the mouth of the Golf Course Arm of Green Lake where it meets the main body of the lake. The purpose of the impoundment (hereinafter "Golf Course Arm impoundment") formed by this structure would be to have an auxiliary storage facility for NSCC use, given that modifications to Green Lake Dam would lower the normal pool level of the main body of the lake to elevation 18.0 feet msl.

The Golf Course Arm impoundment would be operated at an approximate normal pool level of 24.0 feet msl. At this elevation, the new impoundment would store approximately 36 acre-feet of water between elevations 18.0 and 24.0 which would be relatively free of objectionable salinity. A new pump and intake system would need to be installed to move water from the main body of Green Lake to the Golf Course Arm impoundment.



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NSCC DELIVERY SCENARIO 2

FIGURE 2 - 24

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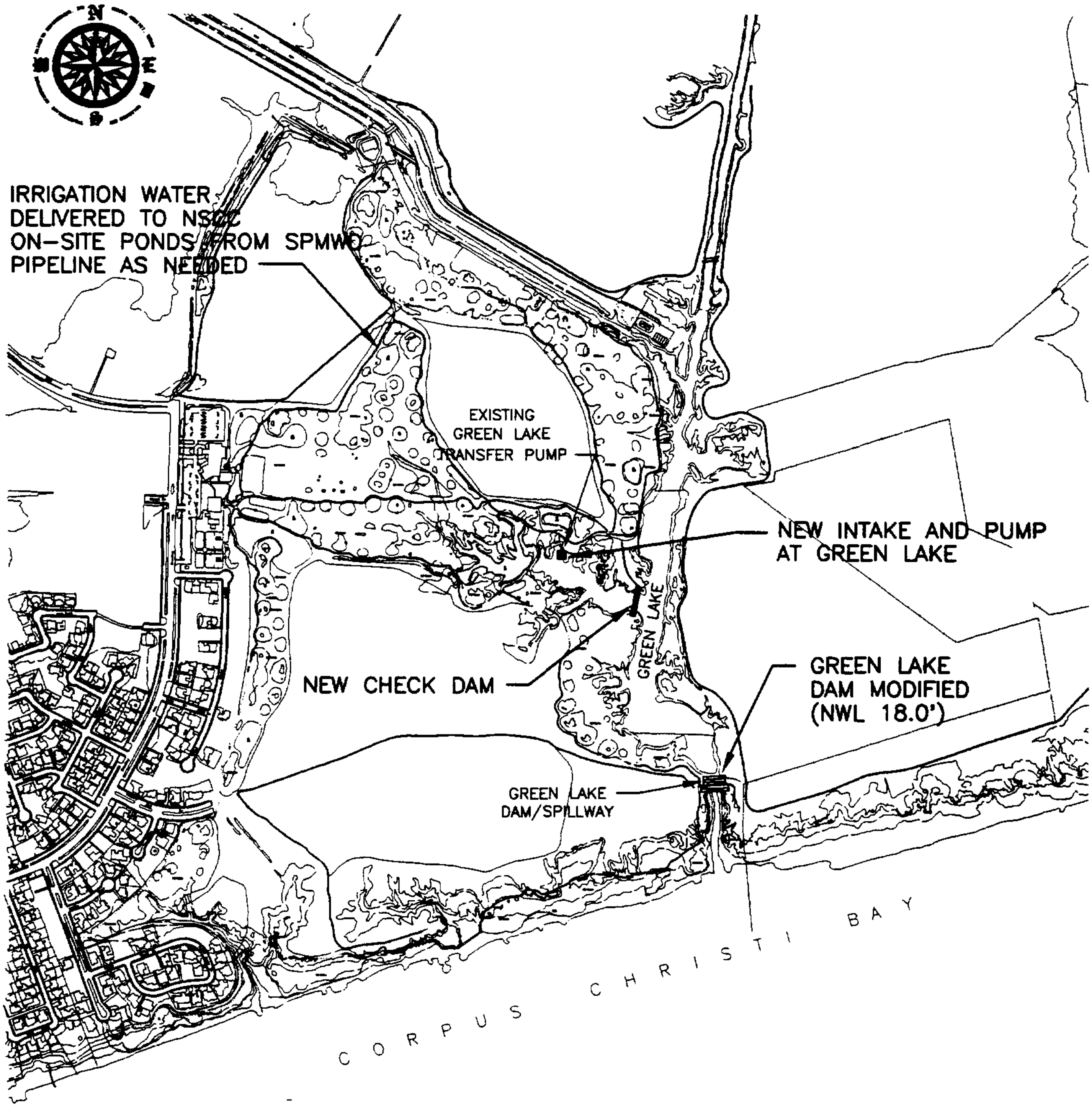
Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:

As in Scenario 1, the amount of water available from Green Lake (and from the Golf Course Arm) is affected by the rate at which treated wastewater is discharged from the City of Gregory plant. Therefore, two cases were considered: Case "A", where Gregory's treated effluent continues to reach Green Lake (annual discharge in 1993 assumed to be 0.18 mgd) and Case "B", where the discharge of treated effluent from the Gregory plant is discontinued through their participation in a regional plant. Under this scenario, on an average annual basis, NSCC could "scalp" 147 acre-feet per year from Green Lake under Case A and 133 acre-feet per year under Case B. Also, 57 acre-feet per year could be obtained from the Golf Course Arm impoundment under Case A and 62 acre-feet per year under Case B. Therefore, NSCC would need to purchase 22 acre-feet of irrigation water per year from the City of Portland under Case A and 31 acre-feet per year under Case B (Figure 2-25). See Section 2.5.6.10 for cost estimates.

Scenarios 4A and 4B

Under this alternative, with the Green Lake Dam spillway modified to reduce the normal pool level from elevation 20.6 to 18.0 feet msl, NSCC would only draw from Green Lake when the lake is spilling (i.e., pool level above elevation 18.0 feet msl). Remaining irrigation water needs would be met through purchases from the San Patricio Municipal Water District under a new rate schedule wherein NSCC would become a direct industrial customer of the SPMWD.

As in Scenarios 1 and 3, the amount of water available from Green Lake is affected by the rate at which treated wastewater is discharged from the City of Gregory plant. Therefore, two cases were considered: Case "A", where Gregory's treated effluent continues to reach Green Lake (annual discharge in 1993 assumed to be 0.18 mgd) and Case "B", where the discharge of treated effluent from the Gregory plant is discontinued through their participation in a regional plant. Under this scenario, on an average annual basis, NSCC could "scalp" 147



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NSCC DELIVERY SCENARIO 3

FIGURE 2 - 25

Drawn By: A. NORIEGA	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.: 3745-CC4
Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:

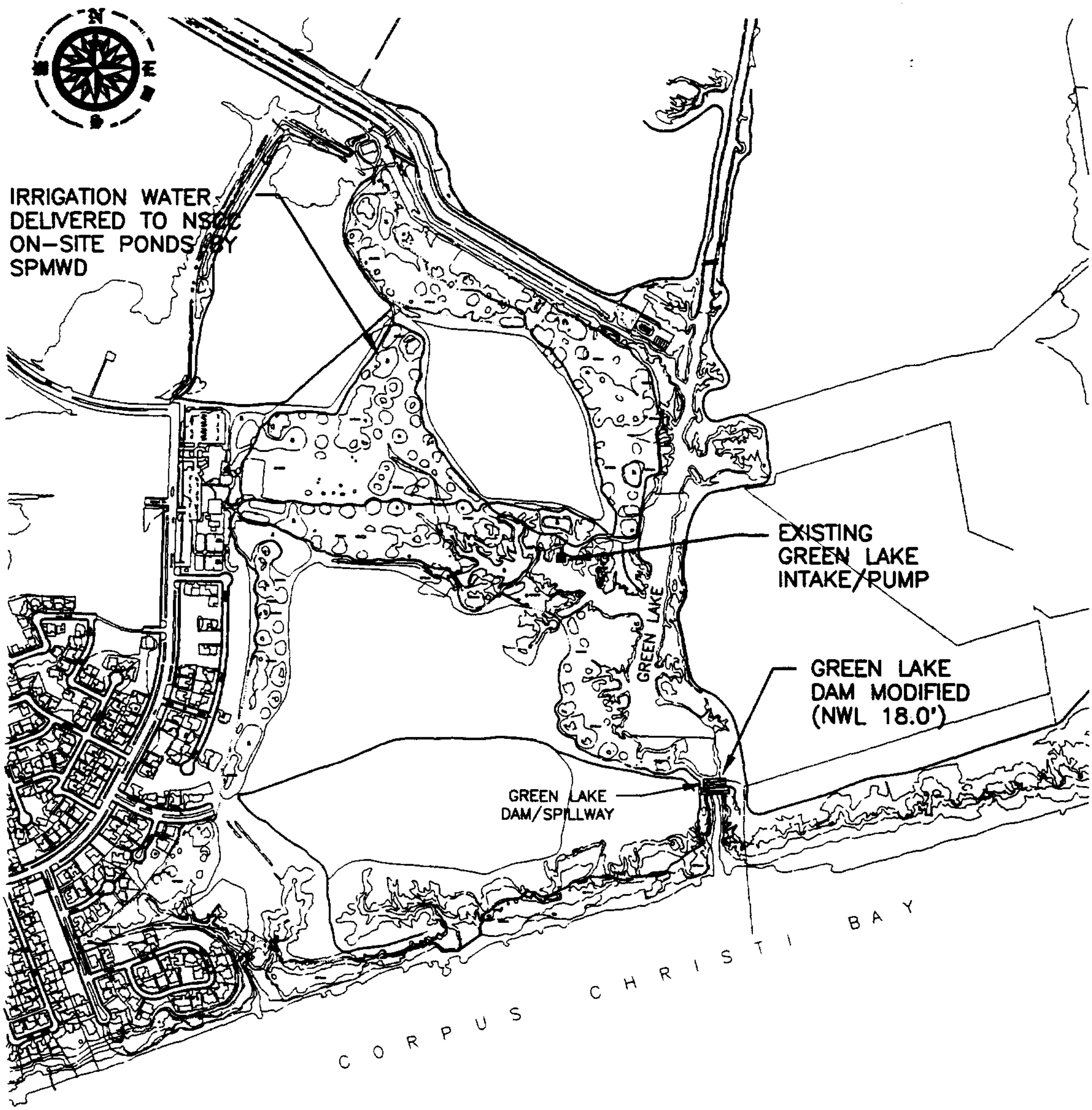
acre-feet per year from Green Lake under Case A and 133 acre-feet per year under Case B. Therefore, NSCC would need to purchase 79 acre-feet of irrigation water per year from the City of Portland under Case A and 93 acre-feet per year under Case B (Figure 2-26). See Section 2.5.6.10 for cost estimates.

2.4.1.2 Reynolds Metals Plant

2.4.1.2.1 Background

Reynolds purchased the Sherwin Plant site (approximately 1600 acres) in 1951. The facility utilizes the Bayer Process to extract the finished product (alumina) from the raw material (bauxite). The Bayer Process is a solution and precipitation process that demands fresh water to satisfy process requirements. The Sherwin Plant was transitioned to a complete zero discharge facility in 1972. Spent liquor (a weak, low concentration caustic) is added to the bauxite prior to a grinding process. The mixture is then sent to desilicators to precipitate silica contained in the bauxite. The main high concentration caustic solution is then added to the bauxite and the mixture is heated under pressure in vessels called digesters to place the aluminum hydrate into solution.

The mixture is then discharged into settlers that separate the dissolved alumina product overflow from the heavier solids (called red mud), which is discharged into an underflow. The overflow is sent to precipitators, where aluminum hydroxide is recovered. The product then goes through a finishing process that includes drying in kilns. The red mud is sent through a series of washers and thickeners to recover as much of the soda (Na_2CO_3) as possible. The process involves a total of 9 stages of washing. Stage 1 is in the last unit of the digestion process (flush tanks) stages 2 through 6 are in the washers and stages 7 through 9 are in the



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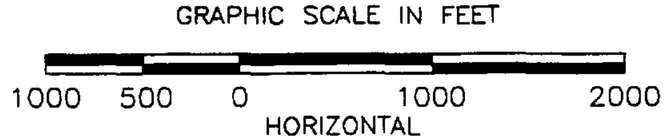

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NSCC DELIVERY SCENARIO 4

FIGURE 2 - 26

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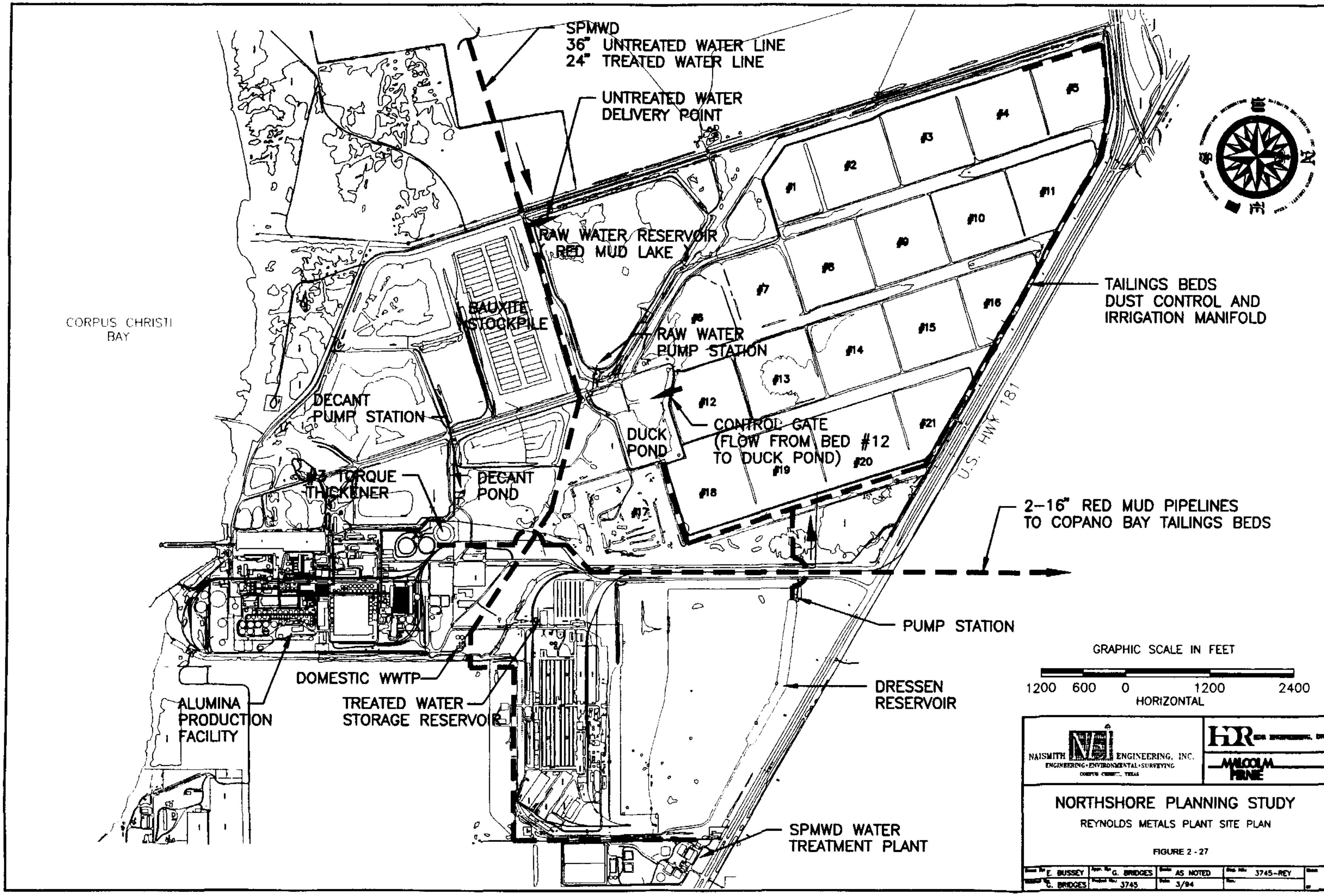
thickeners. A counter-current decant system (CCD circuit) is used to sequentially wash the mud using recycled water from the decant pond.

The portion that remains after all the useful soda has been extracted is a thickened red mud. A large quantity of the red mud is produced in the process. Disposal of the red mud is accomplished by adding water to the underflow from the final thickener to form a slurry with approximately 25 percent solids content. The slurry is then pumped to impoundment areas that are called bauxite tailings beds. Additional water is needed for slaking chemicals, purging digesters and precipitators, washing rail cars, loading docks and service ships, and make up for cooling towers.

Reynolds is currently in the process of reclassification of the original tailings beds from Class I non-hazardous to Class III non-hazardous solid waste disposal sites. The maintenance program includes significant quantities of water for dust control and the establishment of vegetation on the tailings beds. The beds include an underdrain system that allows the process water to be collected and recycled.

2.4.1.2.2 Existing Water System Infrastructure

Potable water enters the Reynolds plant through a 12-inch line from the SPMWD's water treatment plant, and is discharged into a treated water storage reservoir (Figure 2-27). The major uses of potable water in the process include: washing the docks, service ships and rail cars; pressure cleaning of vessels by water blasting; and makeup water for cooling towers. There are two service points for the raw water system. The first is a tap off the 36-inch untreated water line at the southwest corner of the raw water reservoir (known as Red Mud Lake). A pump station on the east side of Red Mud Lake transfers raw water to the plant.



SPMWD
36" UNTREATED WATER LINE
24" TREATED WATER LINE
UNTREATED WATER DELIVERY POINT
RAW WATER RESERVOIR (RED MUD LAKE)
BAUXITE STOCKPILE
RAW WATER PUMP STATION
TAILINGS BEDS DUST CONTROL AND IRRIGATION MANIFOLD
CORPUS CHRISTI BAY
DECANT PUMP STATION
CONTROL GATE (FLOW FROM BED #12 TO DUCK POND)
DUCK POND
#3 TORQUE THICKENER
DECANT POND
U.S. HWY 181
2-16" RED MUD PIPELINES TO COPANO BAY TAILINGS BEDS
PUMP STATION
GRAPHIC SCALE IN FEET
1200 600 0 1200 2400
HORIZONTAL
DOMESTIC WWTP
TREATED WATER STORAGE RESERVOIR
ALUMINA PRODUCTION FACILITY
DRESSEN RESERVOIR
SPMWD WATER TREATMENT PLANT
#1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20 #21
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NORTHSHORE PLANNING STUDY
REYNOLDS METALS PLANT SITE PLAN
FIGURE 2 - 27
E. BUSSEY
G. BRIDGES
AS NOTED
3745-REY
G. BRIDGES
3745
3/94

The second raw water service point is a tap off the 24-inch untreated water line into the eastern side of Dressen Reservoir, located west of the SPMWD's water treatment plant. Water is pumped from the Dressen Reservoir into the tailings bed manifold system for use in irrigation and dust control. Water that leaches through the tailings beds is recovered in an underdrain and ditch system that discharges into a reservoir east of Red Mud Lake and south of the tailings beds, known as the Duck Pond. Due to the spent caustic and lime present in the bauxite tailings, the leached water has a high pH of 10 to 11. The Duck Pond also receives flow from the west ditch, which retains and recirculates wash water used in the dock area.

Decant water from the Duck Pond flows into a 40-acre decant pond system and is pumped to the #3 torque thickener, where it is added to the thickened mud (injection water). The slurry is pumped in a 16-inch pipeline to the active Copano Bay tailings beds. A second parallel 16-inch line currently serves as a standby. The decant pond also receives storm water that is retained and recirculated from the plant's storm sewer collection system. Water from the decant pond also supplies the CCD wash circuit and hose water in the plant.

The high pH water in the Duck Pond is also blended back into Red Mud Lake in order to soften the raw water by precipitating the calcium and magnesium. The pH of the raw water is raised from a pH of 8 to 9 to a pH of approximately 10.5 and the hardness is reduced from approximately 200 mg/L to 30 mg/L.

The original tailings beds consist of 21 cells and were used for mud disposal until 1967, when the Copano Bay facility was placed into service. Cell #6 is currently used for emergency disposal of mud when the Copano facility is temporarily out of service. Untreated water has been used for irrigation on Cell #5 in an experimental program to establish different types of vegetative cover on the bauxite tailings. Cell #17 is currently used as a landfill site. Cell #18 is currently used in an experimental program that utilizes effluent from Reynolds' wastewater treatment plant for dust control and irrigation. Cell #21 is currently used in an experimental program that utilizes municipal sludges (biosolids) from area wastewater treatment plants for dust control and irrigation.

The Copano Bay Facility has an estimated remaining life of 20-years and consists of four (4) beds with sizes as follows:

Bed #1	Approximately 1300 acres
Bed #2	Approximately 480 acres
Bed #3	Approximately 428 acres
Bed #4	Approximately 768 acres

2.4.1.2.3 Existing Water Usage

Treated water usage at the plant averaged approximately 1.1 mgd during 1992 and 1993, or approximately 13 percent of the total treated water sold by the San Patricio Municipal Water District, while untreated water usage averaged approximately 2.8 mgd during 1992 and 1993, which is approximately 40 percent of the total untreated water sold by the SPMWD (Table 2-16). Overall, Reynolds uses approximately 25 percent of the total water (treated and untreated) sold by the SPMWD.

Coinciding with this study, Reynolds conducted an internal water audit to identify water quantity and water quality requirements at the plant. The study was performed by Mr. Praveen Duggal, a graduate student at Texas A & M University, Kingsville. The plant water balance, based on 1993 water inputs and outputs, is 6.91 mgd (Table 2-16).

TABLE 2-16
REYNOLDS METALS PLANT TOTAL WATER BALANCE
(1993 FIGURES)

INPUTS TO THE PLANT	mgd
Raw Water	
Raw Water Reservoir (Red Mud Lake)	2.3
Dressen Reservoir	1.1
Truck Load	0.01
Rainfall Storage (720 ac.)	1.9
Water in the Bauxite	
Moisture	0.2
Hydrate	0.3
Potable Water	1.1
Total	6.91
OUTPUTS FROM THE PLANT	
Cooling Towers	
Power Plant	0.04
Evaporators	1.3
H.E. Flux Coolers	0.02
With Red Mud	2.5
Losses Within Plant	0.35
Kilns	0.7
Evaporation (Tailings beds, decant pond, duck pond, red mud lake)	2.0
Total	6.91

2.4.1.2.4 Water Quality Requirements

The internal water audit conducted by Reynolds involved an evaluation of potential water conservation measures, including possible substitutions of untreated water for more expensive San Antonio treated water.

The audit has resulted in the following reductions in treated water usage:

- Reduced consumption of treated water used for water cooling of bearings on internal draft fans by approximately 200,000 gpd.

- Decant water now used to replace approximately 40,000 gpd of treated water for purge or washing pads at Facility 22 (Grinding).

Additional substitutions or reductions in usage may be implemented in the future to reduce the treated water usage. In addition, untreated water usage may be reduced by substitution with treated effluent. Acceptable water quality requirements for effluent that is proposed for substitution as untreated water are as follows:

- BOD — <20 mg/L
- TSS — 40-50 mg/L
- Chlorides — 300 mg/L maximum
- Sulfates — 300 mg/L maximum

An analysis was performed for Reynolds on a sample of effluent from the Sinton WWTP in July 1993 and showed the following results:

pH	9.05
Bicarbonate alkalinity as CaCO3	190 ppm
Carbonate alkalinity as CaCO3	50 ppm
Total alkalinity as CaCO3	240 ppm
Sulfate as SO_4	140 ppm
Sodium as Na_2O	320 ppm
Magnesium as MgO	10 ppm
Calcium as CaO	50 ppm
Chloride as Cl	230 ppm

In addition, when stored in anaerobic conditions for a period of three days, the sample did not exhibit offensive odors. The above results indicate that the sample would meet the requirements for chlorides and sulfates.

Reynolds also samples leachate from the underdrains of tailings bed #18 and #21, in the vicinity of the current on-site WWTP effluent reuse project. Tests performed on February 7, 14, and 23, 1994 showed BOD_5 concentrations of less than 10 mg/L, which meet the requirements listed above.

Based on the limited data included above, it is concluded that effluent from all study area WWTPs would be suitable for substitution as raw water on the tailings beds, for dust control and irrigation, and subsequently for use as injection water for transport of red mud to the Copano Bay tailings beds.

2.4.1.2.4 Water Quality Requirements

Wastewater effluent data from other industrial facilities in the area (DuPont and Oxychem) were reviewed to determine the feasibility of reuse of these industrial effluents by Reynolds. It was concluded that further analyses will be required in order to determine the long-term effects, if any, that industrial effluent constituents, such as heavy metals, if any, would have on the tailings beds. Thus, reuse of industrial effluent was not given further consideration in this study.

2.5 Alternative Methods of Regional Wastewater Effluent Reuse and Regional Wastewater Treatment

An advisory committee was formed to facilitate the performance of this study. The advisory committee consisted of representatives from area municipalities, industries and agencies (see membership list following title page).

Committee meetings were held at the office of Naismith Engineering, Inc. on May 13, 1993 and October 7, 1993. Members of the committee also held a meeting on February 6, 1994 at the office of Mike Willatt and met with TNRCC staff in Austin on November 3, 1994. Several conceptual regional effluent reuse and wastewater treatment alternatives were developed and presented at the committee meetings. The analysis of these regional effluent reuse alternatives is summarized in Sections 2.5.1 through 2.5.3. The analysis of regional wastewater treatment alternatives is summarized in Sections 2.5.4 through 2.5.7.

2.5.1 Analysis of Regional Wastewater Effluent Reuse Alternatives

During peak periods, the combined fresh water demands from the Northshore Country Club and Reynolds Metals Plant that could be satisfied through effluent reuse is in excess of five mgd (Section 2.4.1.2.5). A review of the existing and projected wastewater flows from the seven municipal plants included in the study indicates that all of the effluent produced at these plants could therefore be reused. However, both the fresh water demands and effluent flows fluctuate on a daily and annual basis, depending upon factors such as rainfall. Due to the proximity of Green Lake to the NSCC and Reynolds Metals, several initial alternatives involved its utilization as a reservoir for storage of effluent flows.

2.5.1.1 Green Lake Wastewater Effluent Reuse Alternatives

The use of Green Lake as an effluent storage reservoir was investigated. Alternatives that were identified for analyses are listed below:

ALTERNATIVE G-1 (E):

* Effluent flow from Portland WWTP to Green Lake
* Irrigation withdrawal from Green Lake to Northshore Country Club (NSCC)
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTP's directly to Reynolds
* Effluent from Sinton, Taft and Odem WWTP's directly to Reynolds

ALTERNATIVE G - 2 (E):

* Effluent flow from Portland WWTP to check dam controlled NSCC irrigation pool
* Irrigation withdrawal from irrigation pool to NSCC
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTP's directly to Reynolds
* Effluent from Sinton, Taft and Odem WWTP's directly to Reynolds

ALTERNATIVE G - 3 (E):

* Effluent from Portland WWTP to Green Lake
* Irrigation withdrawal from check dam controlled irrigation pool to NSCC
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTP's directly to Reynolds
* Effluent from Sinton, Taft and Odem WWTP's directly to Reynolds

ALTERNATIVE G - 4 (E):

* Effluent from Portland WWTP to Green Lake
* Irrigation withdrawal from Green Lake to NSCC
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTP's to Green Lake
* Effluent from Sinton, Taft and Odem WWTP's directly to Reynolds

ALTERNATIVE G - 5 (E):

* Effluent flow from Portland WWTP to Green Lake
* Effluent flow from Gregory WWTP to Green Lake
* Irrigation withdrawal from Green Lake to NSCC
* Effluent from Aransas Pass and Ingleside WWTPs directly to Reynolds
* Effluent from Sinton, Taft and Odem WWTPs directly to Reynolds

ALTERNATIVE G - 6 (E):

* Irrigation withdrawal from Green Lake to NSCC
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTPs directly to Reynolds
* Effluent from Sinton, Taft and Odem WWTP's directly to Reynolds
* Effluent from Regional WWTP to Green Lake

ALTERNATIVE G - 7 (E):

* Irrigation withdrawal from irrigation pool to NSCC
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTP's directly to Reynolds
* Effluent from Sinton and Odem WWTPs directly to Reynolds
* Effluent from Regional WWTP to Green Lake
* Effluent from Regional WWTP to NSCC irrigation pool

ALTERNATIVE G - 8 (E):

* Irrigation withdrawal from irrigation pool to NSCC
* Process water withdrawal from Green Lake to Reynolds

* Effluent from Aransas Pass and Ingleside WWTP's directly to Reynolds
* Effluent from Sinton and Odem WWTPs directly to Reynolds
* Effluent from Regional WWTP to Green Lake

ALTERNATIVE G - 9 (E):

* Irrigation withdrawal from Green Lake to NSCC
* Process water withdrawal from Green Lake to Reynolds
* Effluent from Aransas Pass and Ingleside WWTPs to Green Lake
* Effluent from Sinton and Odem WWTPs directly to Reynolds
* Effluent from Regional WWTP to Green Lake

The primary advantages of regional effluent systems that utilized Green Lake for storage include:

- Possible reduction in regional effluent infrastructure costs.
- Reduction in salinity of Green Lake.
- Providing continuous freshwater source.
- Possibility for maintenance of relatively constant pool elevation.
- Ability to "scalp" excess flows during rainfall events for storage and subsequent use by NSCC and Reynolds.

The primary disadvantage of the use of Green Lake for storage of effluent is the fact that water quality could be degraded due to the increased nutrient and solids loadings. Relocation of effluent discharges into Green Lake would likely result in more stringent treatment requirements at the WWTPs. For example, as previously mentioned, it is anticipated that the City of Portland would be required to upgrade its Main Plant from a 20-20 permit to a 10-15-3 permit if its discharge point were relocated to Green Lake. The capital cost for such an upgrade is estimated to be a minimum of $250,000. Preliminary estimates showed that debt service and increased O & M costs associated with the plant upgrade, when added to the costs of effluent transmission facilities, would exceed the projected value of the effluent.

In addition, alternatives that included construction of a check dam at Green Lake, to provide an irrigation pool for NSCC, would likely change the status of the irrigation pool from an on-channel to an off-channel storage facility. The irrigation pool would be required if the Green Lake water surface elevation was lowered to 18.0 for flood control purposes. In accordance with 31 TAC 310.15, off-channel ponds cannot be located within the five-year floodplain and must be protected from the 100-year flood. It is likely that an off-channel storage pond would have to be designed in accordance with the regulations for pond lining (31 TAC 310.7), which require approved soil or synthetic membrane linings. Similar lining requirements would apply to alternatives that include the use of existing or proposed NSCC golf course ponds for storage of effluent (see Section 2.4.1.1). Based on these factors and discussions with Technical Advisory Committee members, all alternatives that involved the use of Green Lake as an effluent storage reservoir were eliminated from further consideration.

2.5.1.2 Reynolds Metals Wastewater Effluent Reuse Alternative R-1 (E)

Some portions of the Green Lake regional effluent system alternatives include discharge of effluent directly to the Reynolds Metals Plant. As discussed in Section 2.4.1.2, Reynolds currently uses untreated water, effluent from its on-site WWTP and municipal sludges from area WWTPs for dust control and establishment of vegetation at its original tailings beds. Additional effluent from a regional system would be discharged onto the tailings beds and the leachate would be returned to the Reynolds Plant for use as process water. The primary advantages of regional effluent systems that discharge directly to Reynolds include:

- Zero discharge facility does not require NPDES permit.
- Effluent water quality from existing WWTPs meet TNRCC requirements for industrial use.
- WWTP upgrades not required.

- Ease in phasing of improvements.
- Efficient system due to direct transfer of effluent to major end use.

This reuse concept was further analyzed for each of the seven municipal wastewater plants included in the study.

2.5.2 Cost Estimates for Wastewater Effluent Reuse Alternative R-1 (E)

Evaluation of the concept of discharging effluent directly to Reynolds included estimation of capital and annual O & M costs for new effluent pumping and transmission facilities. Descriptions of required facilities and their costs are presented in the following sections. The types, special features and capacities of effluent pump stations will be determined during preliminary and final design. For purposes of these conceptual cost estimates, pump stations were sized for a firm pump capacity of 3Q (average daily flow in year 2020 times a peak factor of 3). The assumption was made that peak wet weather flows in excess of pump station capacities would be allowed to discharge directly at the existing discharge points. Final design and permitting will determine the feasibility of this scenario. In some cases, facilities may need to be sized to handle peaks in excess of 3Q in order to eliminate requirements for dechlorination of effluents at existing discharge points. Schematics, routing, cost estimate figures, and tables are all shown in Appendix B.

2.5.2.1 Phase 1 - Portland

Proposed facilities include:

- Piping diversion of existing effluent discharge into new effluent pump station.
- Effluent pump station at main WWTP site.
- 16-inch effluent main from pump station to Reynolds Metals Plant tailings beds.

Preliminary estimates of total project capital cost and total annual cost are $1.29 million and $166 thousand, respectively (Table 2-17).

2.5.2.2 Phase 2 - Gregory

Proposed facilities include:

- Piping diversion of existing effluent discharge into new effluent pump station.
- Effluent pump station at existing WWTP site.
- 8-inch effluent main from pump station to Reynolds Metals Plant tailings beds.

Preliminary estimates of total project capital cost and total annual cost are $388 thousand and $59 thousand, respectively (Table 2-17).

TABLE 2-17
REGIONAL EFFLUENT REUSE FACILITIES COST SUMMARY

City	Effluent Flow		Capital Cost (million)	Annual Cost ($1,000)	Cost/ Ac-ft
	MGD	Ac-ft/yr			
Portland	1.25	1400	$1.29	$166	$118
Gregory	0.24	269	0.39	$59	$219
Aransas Pass	0.93	1042	2.24	$268	$257
Ingleside	0.47	526	1.16	$152	$289
Aransas Pass (Combined with Ingleside)	0.93	1042	2.18	$261	$250
Ingleside (Combined with Aransas Pass)	0.47	526	1.08	$139	$264
Taft	0.52	582	1.39	$161	$277
Taft (Combined with Sinton)	0.52	582	0.82	$105	$180
Sinton (Combined with Taft)	0.50	560	1.92	$221	$395
Odem (Combined with Taft and Sinton)	0.12	134	1.62	$187	$1396

*See Appendix B

2.5.2.3 Phase 3 - Aransas Pass and Ingleside Combined

Proposed facilities include:

- Piping diversion of existing effluent discharge into new effluent pump station at Aransas Pass WWTP.
- Effluent pump station at existing WWTP site.
- 16-inch effluent main from pump station to point of connection with Ingleside effluent main.
- Piping diversion of existing effluent discharge into new effluent pump station at Ingleside WWTP.
- Effluent pump station at existing WWTP site.
- 12-inch effluent main from pump station to point of connection with Aransas Pass effluent main.
- 20-inch effluent main from point of connection to Reynolds Metals Plant tailings beds.

Preliminary estimates of total capital costs and annual costs show that a combined Aransas Pass and Ingleside facilities would lower capital and annual costs to each entity. For example, an Aransas Pass facility would have a capital cost of $2.24 million and an annual cost of $268 thousand, whereas, an Aransas Pass/Ingleside facility would cost Aransas Pass $2.18 million in capital outlay and have an annual cost of $261 thousand (Table 2-17).

An Ingleside facility would have a capital cost of $1.16 million and an annual cost of $152 thousand, while Ingleside's share of a facility combined with Aransas Pass would have a capital cost of $1.07 million and an annual cost of $139 thousand (Table 2-17).

2.5.2.4 Phase 4 - Taft

Proposed facilities include:

- Piping diversion of existing effluent discharge into new effluent pump station.

- Effluent pump station at existing WWTP site.
- 12-inch effluent main from pump station to Reynolds Metals Plant tailings beds.

Preliminary estimates of total project capital cost and total annual cost are $1.39 million and $161 thousand, respectively (Table 2-17).

2.5.2.5 Phase 4A - Taft and Sinton Combined

In addition to the Taft effluent facilities previously listed, proposed facilities for Sinton include:

- Piping diversion of existing effluent discharge into new effluent pump station at Sinton WWTP.
- Effluent pump station at existing WWTP site.
- 12-inch effluent main from pump station to point of connection with Taft effluent main.

Preliminary capital cost estimates for a Taft facility combined with Sinton are $816 thousand, with annual costs of $105 thousand (Table 2-17). These are lower than for a stand-alone Taft facility ($1.39 million and $161 thousand). Costs to Sinton for a Sinton facility combined with Taft are estimated at $1.92 million in capital outlay, with an annual cost of $221 thousand (Table 2-17).

2.5.2.6 Phase 4B - Taft, Sinton and Odem Combined

In addition to the Taft and Sinton effluent facilities previously listed, proposed facilities for Odem include:

- Piping diversion of existing effluent discharge into new effluent pump station at Odem WWTP.

- Effluent pump station at existing WWTP site.
- 8-inch effluent main from pump station to point of connection with Taft and Sinton effluent main.

Preliminary estimates of total project capital cost and total annual cost to Odem are $1.62 million and $187 thousand, respectively (Table 2-17).

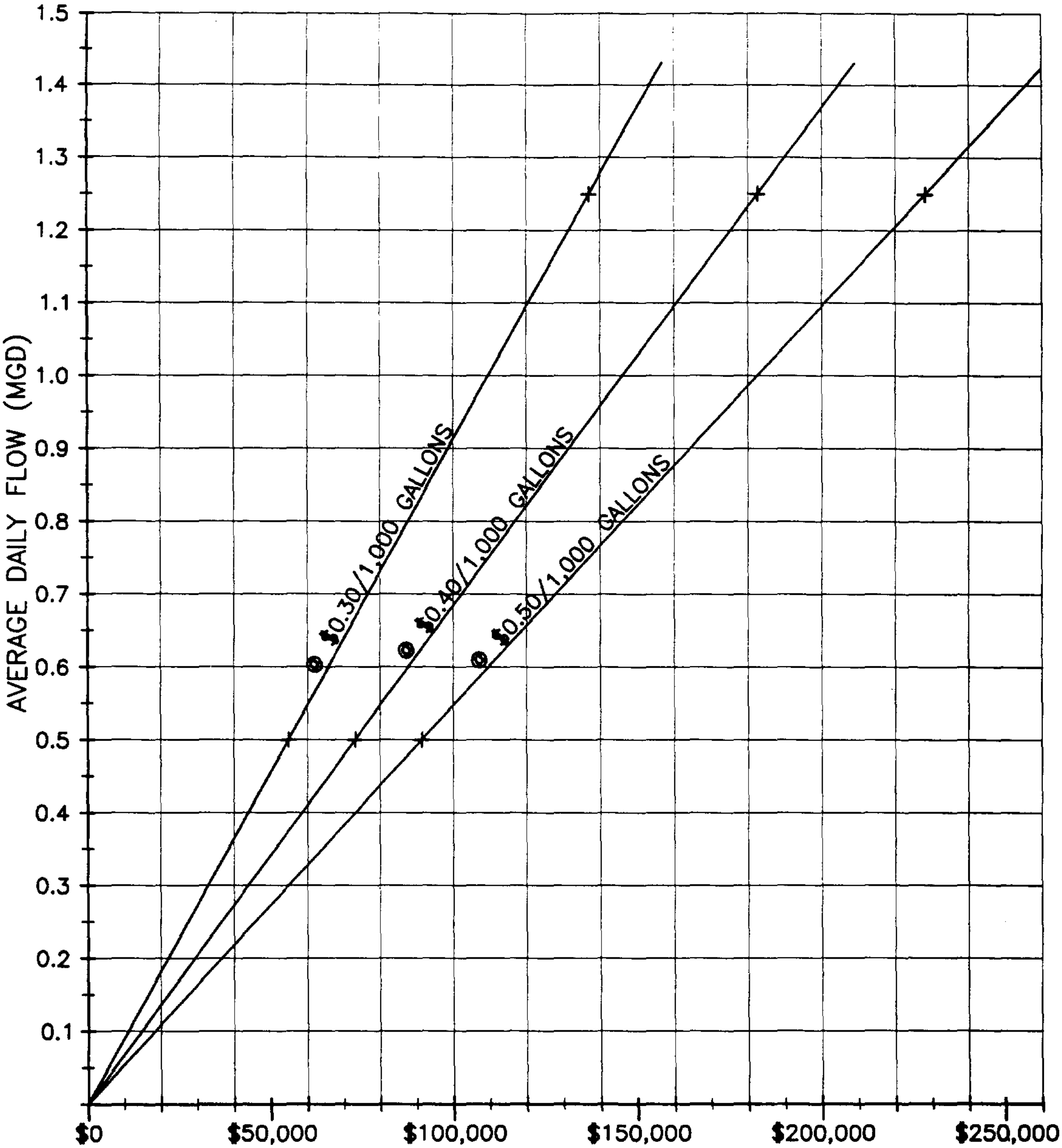
2.5.3 Economic Feasibility of Wastewater Effluent Reuse Alternative R-1 (E)

In this report, the economic feasibility of regional effluent reuse is based on the fact that substitution of effluent to satisfy freshwater needs currently being met by untreated water from the SPMWD or Green Lake has an economic value. The annual revenue that would be generated through the sale of treated effluent at average daily flow (ADF) rates up to 1.2 mgd and unit prices of $0.30, $0.40 and $0.50 per 1000 gallons is shown in Figure 2-28. For each city or feasible combination of cities, this baseline value of available annual revenue was compared against the total annual cost of required effluent pumping and transmission facilities. Effluent flow rates used in this comparison were based on actual per capita flows presented in Section 2.1.3 and population projections for the year 2000. For purposes of this evaluation, a unit price of $0.40/1000 gallons was used to determine a baseline value of the effluent.

An additional economic benefit to some cities is the fact that future upgrades of existing WWTPs to meet more stringent effluent limitations may not be required if the discharge is relocated to the Reynolds tailings bed. For example, Portland may eliminate the need for dechlorination facilities by diverting its effluent to Reynolds.

2.5.3.1 Phase 1 - Portland

The total annual cost of effluent facilities for Portland is $164,000 (Table 2-17). The



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NORTHSHORE PLANNING STUDY

ANNUAL VALUE OF EFFLUENT

FIGURE 2 - 28

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: NONE	Dwg. No.: 3745–CH1
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:

total annual revenue generated through the sale of effluent would be $183,000, which results in a benefit-cost ratio of 1.1. Assuming that savings of approximately $76,000/yr in future WWTP capital and O & M costs (installation of UV disinfection system to meet TNRCC requirements and plant upgrade to meet more stringent effluent limitations required at permit renewal) are included in the analysis, at a 10 percent interest rate, the benefit-cost ratio increases to 1.6 (Table 2-18). At 7 percent interest, the benefit-cost ratio increases to 1.8 and at 5 percent, the benefit-cost ratio would be 2.0 (Table 2-19).

2.5.3.2 Phase 2 - Gregory

The total annual cost of effluent facilities for Gregory is $59,000. The total annual revenue generated through the sale of effluent would be $35,000, which results in a benefit-cost ratio of 0.6 (Table 2-18) at eight percent interest rate and to 0.7 at five percent interest rate (Table 2-19).

2.5.3.3 Phase 3 - Aransas Pass

The total annual cost of effluent facilities for Aransas Pass is $268,000 (Table 2-33). The total annual revenue generated through the sale of effluent is $136,000, which results in a benefit-cost ratio of 0.5. Assuming that savings of approximately $75,000/yr in future WWTP capital and O & M costs (installation of UV disinfection system to meet TNRCC requirements and plant upgrade to meet more stringent effluent limitations required at permit renewal) are included in the analysis, the benefit-cost ratio is 0.8 (Table 2-18), at 8 percent interest rate and is 1.0 at 5 percent interest rate (Table 2-19).

TABLE 2-18

REGIONAL EFFLUENT FACILITIES BENEFIT-COST RATIO

City	Effluent Flow MGD[1]	Annual Benefit (In Thousands of Dollars)			Annual Cost (In Thousands of Dollars)			Benefit-Cost Ratio
		Value of Effluent	Savings in Plant Upgrade Cost	Total Benefit	Debt Service	O & M	Total Cost	
Portland	1.25	$183	$76	$259	$129	$35	$164	1.6
Gregory	0.24	$35	-	$35	$40	$19	$59	0.6
Aransas Pass	0.93	$136	$75	$211	$229	$39	$268	0.8
Ingleside	0.47	$69	-	$69	$119	$33	$152	0.5
Aransas Pass (combined with Ingleside)	0.93	$136	$75	$211	$222	$39	$261	0.8
Ingleside (combined with Aransas Pass)	0.47	$69	-	$69	$110	$29	$139	0.5
Taft	0.52	$76	-	$76	$142	$19	$161	0.5
Taft (combined with Sinton)	0.52	$76	-	$76	$83	$22	$105	0.7
Sinton (combined with Taft)	0.50	$73	-	$73	$196	$25	$221	0.3
Odem (combined with Taft and Sinton)	0.12	$18	-	$18	$165	$22	$187	0.1

[1]From Table 2-5.

TABLE 2-19

REGIONAL EFFLUENT FACILITIES
COST SENSITIVITY ANALYSIS WITH VARYING INTEREST RATES

City	Total Benefit	Total Cost (Debt Service & O & M)			Benefit - Cost Ratio		
		@ 7%	@ 6%	@ 5%	@ 7%	@ 6%	@ 5%
Portland	$259	$143-167	$136-159	$128-149	1.6-1.8	1.6-1.9	1.7-2.0
Gregory	$35	$52-59	$50-57	$47-54	0.6-0.7	0.6-0.7	0.6-0.7
Aransas Pass	$211	$228-271	$216-256	$202-238	0.8-0.9	0.8-1.0	0.9-1.0
Ingleside	$69	$131-154	$125-146	$118-136	0.4-0.5	0.5-0.6	0.5-0.6
Aransas Pass (combined with Ingleside)	$211	$223-263	$211-249	$197-232	0.8-0.9	0.8-1.0	0.9-1.1
Ingleside (combined with Aransas Pass)	$69	$120-140	$114-133	$107-125	0.5-0.6	0.5-0.6	0.6
Total of Aransas Pass & Ingleside combined	$280	$343-403	$325-382	$304-357	0.7-0.8	0.7-0.9	0.8-0.9
Taft	$76	$137-163	$129-153	$120-142	0.5-0.6	0.5-0.6	0.5-0.6
Taft (combined with Sinton)	$76	$91-106	$86-100	$81-94	0.7-0.8	0.8-0.9	0.8-0.9
Sinton (combined with Taft)	$73	$187-224	$176-211	$164-196	0.3-0.4	0.3-0.4	0.4
Odem (combined with Taft and Sinton)	$18	$159-189	$150-179	$140-166	0.1	0.1	0.1

2.5.3.4 Phase 3 A - Ingleside

The total annual cost of effluent facilities for Ingleside is $152,000 (Table 2-17). The total annual revenue generated through the sale of effluent is $69,000, which results in a benefit-cost ratio of 0.5 (Table 2-18), at eight percent interest rate and is 0.6 at five percent interest rate (Table 2-19).

2.5.3.5 Phase 3 B - Aransas Pass and Ingleside Combined

Assuming that a system of combined effluent flows from Aransas Pass and Ingleside is constructed, the total annual cost for Aransas Pass is reduced to $261,000 (Table 2-17). The total annual cost for Ingleside is reduced to $139,000 (Table 2-26). Benefit-cost ratios remain below 1.0 with the combined flow (Table 2-18) when interest rates are 8 percent, and range up to 0.9 when interest rates are 5 percent (Table 2-19).

2.5.3.6 Phase 4 - Taft

The total annual cost of effluent facilities for Taft is $161,000 (Table 2-17). The total annual revenue generated through the sale of effluent is $76,000, which results in a benefit-cost ratio of 0.5 (Table 2-18), at 8 percent interest rate and 0.9 when interest rate is 5 percent (Table 2-19).

2.5.3.7 Phase 4 A - Sinton and Taft Combined

The total annual costs of effluent facilities, assuming flows from Sinton and Taft are combined, are $221,000 for Sinton and $105,000 for Taft (Table 2-17). The total annual revenue generated through the sale of effluent is $73,000 for Sinton, which results in a benefit-cost ratio of 0.3 (Table 2-18). The benefit-cost ratio for Taft is 0.7 at 5 percent interest rate, the benefit-cost ratio is 0.4 (Table 2-19).

2.5.3.8 Phase 4 B - Odem, Sinton and Taft Combined

The total annual cost of effluent facilities for Odem, assuming flows from Odem are combined with Sinton and Taft, is $187,000 (Table 2-17). The total annual revenue generated through the sale of effluent is $18,000 for Odem, which results in a benefit-cost ratio of 0.1 at all interest rates studied (Table 2-19).

2.5.4 Analysis of Regional Wastewater Treatment Alternatives

In addition to the alternatives for reuse of secondary treated wastewater presented in Section 2.4, the scope of this study included an analysis of alternatives for collecting untreated wastewater for treatment at a regional WWTP. The regional WWTP concept provides an alternative means for delivery of treated effluent to the end users and may result in an economy-of-scale benefit as well as other economic and non-economic (i.e., liability, legal, workers compensation, future permit uncertainty, etc.) benefits to customer cities.

The concept of regional wastewater treatment in eastern San Patricio County was also evaluated in the previously mentioned 1970's E.P.A. Grant Study performed by NEI for the SPMWD. The 1970's study evaluated four alternatives for wastewater treatment in Aransas Pass, Ingleside, Taft and Gregory as follows:

- Upgrade and expand existing WWTPs at each city.
- Combine Aransas Pass and Ingleside into a regional WWTP and upgrade existing WWTPs at Taft and Gregory.

- Construct a central regional WWTP for all four cities.
- Construct a new WWTP at Taft and upgrade/expand existing WWTPs at the other three cities.

In the 1970's study, alternatives involving regional WWTPs were determined to be more expensive than alternatives that included upgrading and expanding existing facilities. Evaluation of the central regional WWTP alternative also included an analysis of the value of reused effluent that could be used to offset the costs of new facilities. It was determined that the value of the effluent was not sufficient to justify the additional cost associated with transporting raw wastewater to the regional WWTP. The Study recommended upgrading and expanding existing WWTPs at Aransas Pass, Ingleside and Gregory, and construction of a new WWTP for Taft.

2.5.4.1 Wastewater Treatment Alternatives with Effluent Discharge to Green Lake

Alternatives G-6 through G-9, as presented in Section 2.5.1.1., include the concept of construction of a new regional WWTP to treat the combined flows from feasible combinations of customer cities. Alternative G-6, G-8 and G-9 involved discharge of effluent from the regional WWTP into Green Lake and subsequent withdrawal and reuse by NSCC and Reynolds metals. Alternative G-7 involved discharge of effluent from the regional WWTP into Green Lake, for subsequent use by Reynolds Metals, and discharge of effluent directly into a check dam controlled irrigation pool at NSCC (or into existing or proposed golf course lakes).

As previously discussed, the advantages of discharging effluent into Green Lake include:

- Reduction of salinity of Green Lake through increased fresh water inflows.
- Possibility for maintenance of relatively constant pool elevation.

Similar to the existing WWTPs, the primary disadvantage of discharge into Green Lake involves water quality and permitting concerns. The regional WWTP would likely be required to meet effluent limitations that are more stringent than many of the existing plants. The treatment requirements would result in higher capital and O & M costs. Another disadvantage is the fact that alternatives involving discharge to irrigation pools at NSCC would be required to meet the regulations for pond lining as discussed in Section 2.4.1. The additional capital and O & M costs associated with these facilities are discussed in Section 3.7. Based on the water quality and economic concerns described above, alternatives that included discharge of effluent from the regional WWTP into Green Lake or NSCC were eliminated from further consideration.

2.5.4.2 Wastewater Treatment Alternative with Effluent Discharge to Reynolds

This alternative was developed as a result of discussions with Advisory Committee members and representatives from the SPMWD and Reynolds Metals Company, and is based on a zero discharge facility at Reynolds. The alternative includes a regional WWTP that discharges effluent directly to the tailings beds for reuse. The end use of the regional WWTP effluent will be a controlled industrial reuse, with no access to the application sites available to the general public. Water quality for reuse at Reynolds requires the wastewater to be treated only to primary standards. Alternative R-1 includes the concept of a primary treatment facility that would allow the use of simple, rugged, proven and low cost treatment systems.

Discussions with the TNRCC staff indicate that primary treatment and application of all effluent on the Reynolds tailings beds would be acceptable if:

- The reuse water had no impact on the ground water in the area.
- The reuse water can be contained on the Reynolds site during a rainfall event equal to the worst storm of record of the last 25 years.

A water balance was performed for land disposal of effluent on the Reynolds tailings beds in accordance with 31 TAC 309.20 and is shown in Table 2-20. Based on an average daily effluent flow of 2.5 mgd, storage volume requirements were calculated in accordance with 31 TAC 309.20 and are shown in Table 2-21. An application site of 783 acres is required, with a storage volume of 143 days (Table 2-21). The effective application rate is approximately 2,250 gallons/acre/day. Design of a system in accordance with the regulations would result in a zero discharge site. The water balance, storage requirements and resulting application rates, as specified by 31 TAC 309.20, are based on utilizing native soils and limiting hydraulic and nutrient application rates for production of a crop of grasses or grains on the application site.

The Reynolds tailings beds are an engineered system which includes interception and collection of leachate at the bottom of the beds. Leachate is presently collected and returned to an on-site storage facility (Red Mud Lake) for reuse. Based on available data from Reynolds Metals on BOD concentrations of wastewater applied to the tailings beds and the leachate, a BOD reduction through the beds of 40 to 70 percent can be expected. There are no data on application rates of wastewater from the Reynolds on-site WWTP.

Based on the requirements of 31 TAC 309.20, and the availability of the existing system for collection of any leachate from the tailings beds, it appears that application of primary effluent to the beds would be feasible. However, in order to better quantify hydraulic application rates and expected BOD removal through the tailings beds, pilot column studies are recommended.

A sub-alternative for Alternative R-1 was evaluated for providing additional treatment to 0.5 mgd of primary effluent for reuse as irrigation water at NSCC. This sub-alternative was evaluated in order to satisfy irrigation demands in lieu of treated effluent discharge to NSCC.

TABLE 2-20

REYNOLDS METALS COMPANY TAILINGS BEDS WATER BALANCE

Month	Avg. Precip (1)	Avg. Runoff (2)	Avg. Infiltrated Rainfall	Evapotran -spiration	Required Leaching	Total Water Needs	Effluent Needed in Root Zone	Evaporation from Reser. Surface (3)	Effluent to be Applied	Consumption from Reservoir
Jan.	1.78	0.28	1.50	0.80	0.00	0.80	0.00	0.09	0.00	0.09
Feb.	1.91	0.34	1.57	1.20	0.00	1.20	0.00	0.11	0.00	0.11
Mar.	1.29	0.10	1.19	2.80	0.54	3.34	2.15	0.24	2.53	2.77
April	1.96	0.38	1.58	3.40	0.61	4.01	2.43	0.24	2.85	3.09
May	3.33	1.47	1.86	6.10	1.41	7.51	5.65	0.22	6.65	6.87
June	2.78	0.82	1.96	6.50	1.51	8.01	6.05	0.34	7.12	7.46
July	2.27	0.53	1.74	6.70	1.65	8.35	6.61	0.51	7.78	8.29
Aug.	3.07	1.35	1.72	4.60	0.96	5.56	3.84	0.49	4.52	5.01
Sept.	5.12	2.65	2.47	5.10	0.88	5.98	3.51	0.27	4.13	4.40
Oct.	3.17	1.08	2.09	4.10	0.67	4.77	2.68	0.30	3.15	3.45
Nov.	1.76	0.27	1.49	2.10	0.20	2.30	0.81	0.23	0.96	1.19
Dec.	1.80	0.29	1.51	1.00	0.00	1.00	0.00	0.18	0.00	0.18
Total	30.24	9.56	20.68	44.40	6.43	52.83	38.73	3.22	39.69	42.91

(1) Average precipitation data for years 1940 - 1990
(2) Average runoff calculated from curve 75 in SCS Manual "Urban Hydrology for Small Watersheds"
(3) Average evaporation data for period 1966 - 1990

TABLE 2-21

STORAGE REQUIREMENTS FOR 2.5 MGD WWTP

Month	Effluent Received for Appl. or Stor. (1)	Rainfall Worst Year in Past 25 Years (2)	Runoff Worst Year in Past 25 Years	Infiltrated Rainfall (3)	Available Water	Net 25 Yr. Low Evap. from Reservoir (4)	Storage	Accumulated Storage
Jan.	3.57	2.89	0.89	2.00	5.57	0.00	3.57	10.10
Feb.	3.57	3.10	1.23	1.87	5.44	0.06	3.51	13.61
Mar.	3.57	2.09	0.43	1.66	5.23	0.13	1.77	15.38
April	3.58	3.18	1.16	2.02	5.60	0.00	1.49	16.87
May	3.58	5.40	2.78	2.62	6.20	0.00	-2.49	14.37
June	3.58	4.51	2.05	2.46	6.04	0.13	-3.50	10.87
July	3.58	3.68	1.43	2.25	5.83	0.44	-4.14	6.73
Aug.	3.58	4.98	2.44	2.54	6.12	0.36	-0.73	6.00
Sept.	3.58	8.31	5.32	2.99	6.57	0.27	-0.42	5.58
Oct.	3.58	5.14	2.57	2.57	6.15	0.42	0.00	0.00
Nov.	3.57	2.86	0.87	1.99	5.56	0.34	2.72	2.52
Dec.	3.57	2.92	0.91	2.01	5.58	0.32	4.21	6.53
Total	42.91	49.06	22.08	26.98	69.89	2.47		

Acres Req'd 783

Required Storage Volume (gal) 358,647,888
Days of Storage 143

(1) Based on average yearly consumption from reservoir for water balance calculation
(2) Based on annual rainfall data for the year 1980
(3) Runoff calculated from curve 75 in SCS Manual "Urban Hydrology for Small Watersheds"
(4) Evaporation data for 25 year low based on year 1966

Construction cost for the additional treatment facilities is estimated to be $750,000. This cost is for the treatment plant only, and does not include costs for pumping and storage of the effluent. The sub-alternative is eliminated for further consideration due to its prohibitively high costs.

2.5.5 Design Criteria for Regional WWTP

2.5.5.1 Capacity

The proposed capacity of the regional WWTP is based on wastewater flow projections presented in Section 2.1.3 and the following assumptions:

- Plant will be sized for flows through the year 2020.
- TNRCC regulations regarding requirement to commence design of plant expansion when flow reaches 75 percent of capacity and to commence construction when flow reaches 90 percent of capacity will be respected (75-90 Rule).
- Recommended planning value for wastewater flow of 100 gpcd is used for all cities except Aransas Pass.
- Actual per capita flow of 115 gpcd is used for Aransas Pass.
- Plant would be planned and sized to accommodate phasing.

For purposes of preparing WWTP cost estimates, the following construction phasing scenarios were established:

<u>Scenario 1</u>

- Proposed Phase 1 - Initial 2.5 mgd module
- Future Phase 2 - Additional 2.5 mgd expansion for a total of 5.0 mgd.
- Future Phase 3 - Final 2.5 mgd expansion for a total of 7.5 mgd.

The 2.5 mgd module planned for Phase 1 is sized to handle the combined projected year

2020 ADF from Portland (1.65 mgd) and Gregory (0.48 mgd). Based on the previously mentioned TNRCC 75-90 Rule and projections from Section 2.1.3, design of a plant expansion would need to occur in approximately year 2010.

It is also feasible for the initial treatment module to be sized to handle flow from Portland only. In this case, an initial 2.0 mgd plant could handle flows through the year 2010 before design of an expansion would be required. However, based on the fact that Portland's Main Plant has current capacity for 2.5 mgd, it was assumed that 2.5 mgd would be the smallest increment constructed.

The 2.5 mgd expansion is sized to handle the combined projected year 2020 ADF from Aransas Pass (1.22 mgd) and Ingleside (1.04 mgd), giving a 5.0 mgd plant which would have adequate capacity for Portland, Gregory, Aransas Pass and Ingleside through the year 2020. Based on the 75-90 Rule, design of an expansion to the 5.0 mgd plant would need to occur at approximately year 2010.

The final 2.5 expansion is sized to handle the combined projected year 2020 ADF from Taft (0.67 mgd), Sinton (0.82 mgd) and Odem (0.32 mgd), resulting in a 7.5 mgd plant that could handle projected flows for all the participants.

Scenario 2

- Proposed Phase 1 - Initial 5.0 mgd module.
- Future Phase 2 - Additional 2.5 mgd expansion for a total of 7.5 mgd.

Under this scenario, the 5.0 mgd module would handle the combined flows from Portland, Gregory, Ingleside, Aransas Pass and Taft through the year 2010. Under the 75-90 Rule, construction of a plant expansion would need to occur at that time.

2.5.5.2 Alternative R-1 - Primary Treatment Process

A flow schematic for the recommended WWTP is shown in Figure 2-29. Design criteria for each of the wastewater unit processes is shown in Table 2-22. The schematic shown is only one possible scenario for primary treatment, and was prepared for the purpose of obtaining cost estimates. Other treatment scenarios likely exist and should be evaluated in subsequent stages of this project.

It is recommended that the influent wastewater stream would be screened by rotary-type fine screens prior to the biological filters. The fine screening is required to prevent plugging of the orifices in the filter rotary distributor as well as the filter media. Two filters are recommended for redundancy and reliability. The filters have been conservatively sized for a hydraulic loading rate of 2 gpm/ft^2 at average flows and 4 gpm/ft^2 at peak conditions. Corresponding BOD loading rates are 230 and 460 lbs/day/1000 ft^3, respectively. Due to the relatively high hydraulic loading rate, filter recycle will not be required.

The primary clarifier has been sized in accordance with TNRCC design criteria for an average overflow rate of 900 gpd/ft^2 and a peak overflow rate of 1800 gpd/ft^2. the literature shows that solids concentrations of 4 percent are easily achieved for settled sludge from a trickling filter plant.

Aerobic digestion is recommended for sludge stabilization. It is assumed that the end use of the sludge will be land application in the liquid form for vegetative growth on tailings bed closures at Reynolds Metals. Stabilization methods such as lime or kiln dust were not considered since the end use will be on soils which are already alkaline in nature. Application in the liquid form is recommended to avoid the cost of dewatering equipment.

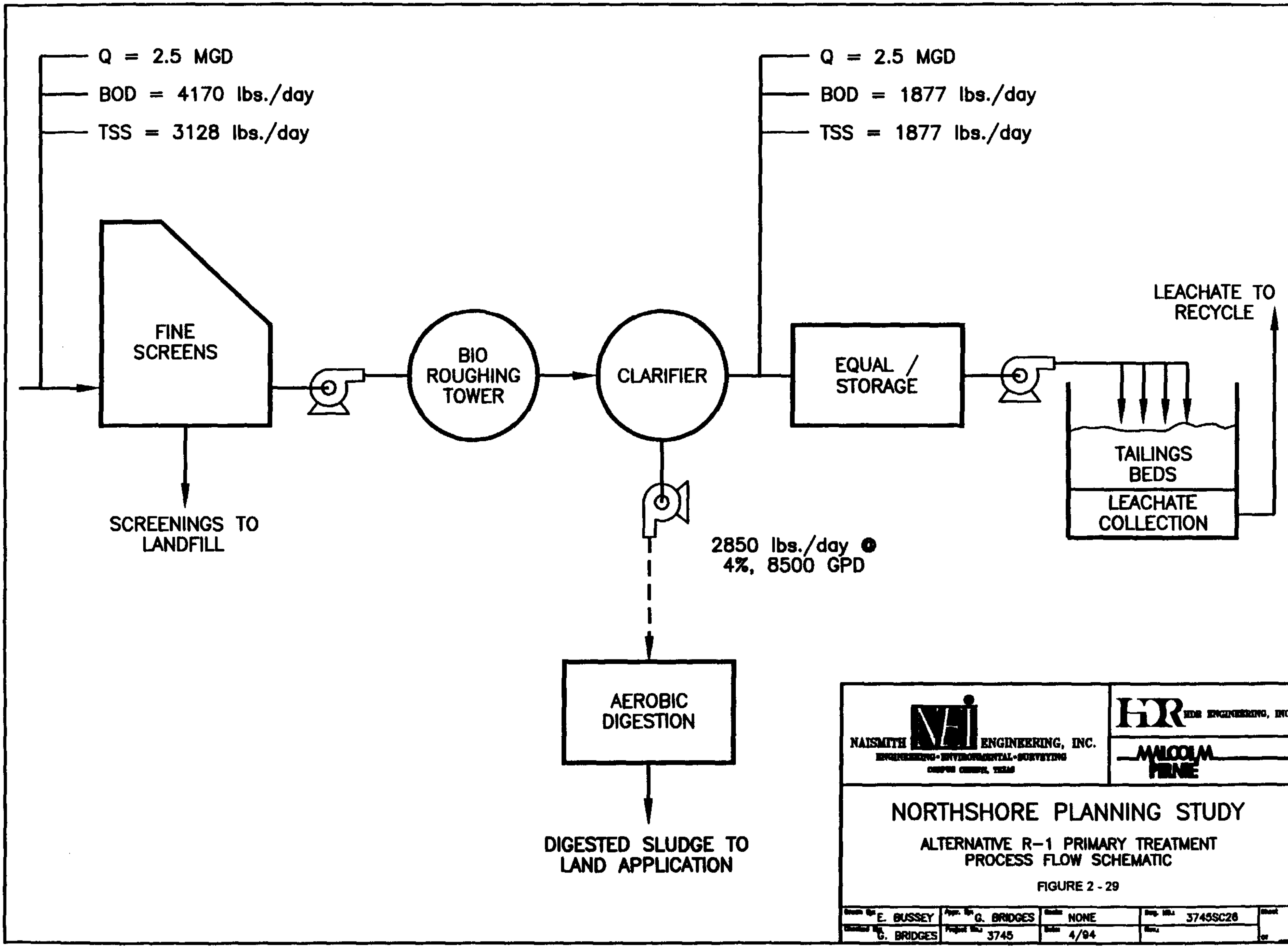
Q = 2.5 MGD
BOD = 4170 lbs./day
TSS = 3128 lbs./day
FINE SCREENS
SCREENINGS TO LANDFILL
BIO ROUGHING TOWER
CLARIFIER
Q = 2.5 MGD
BOD = 1877 lbs./day
TSS = 1877 lbs./day
EQUAL / STORAGE
LEACHATE TO RECYCLE
TAILINGS BEDS
LEACHATE COLLECTION
2850 lbs./day @ 4%, 8500 GPD
AEROBIC DIGESTION
DIGESTED SLUDGE TO LAND APPLICATION
NAISMITH ENGINEERING, INC.
MALCOLM PIRNIE
NORTHSHORE PLANNING STUDY
ALTERNATIVE R-1 PRIMARY TREATMENT PROCESS FLOW SCHEMATIC
FIGURE 2 - 29
E. BUSSEY
G. BRIDGES
G. BRIDGES
3745
NONE
4/94
3745SC26

TABLE 2-22
DESIGN CRITERIA FOR REGIONAL WWTP

	UNITS
INFLUENT WASTEWATER CHARACTERISTICS	
Average Daily Flow:	2.5 MGD
Peak Daily Flow:	5.0 MGD
Minimum Daily Flow:	1.25 MGD
Average BOD Concentration:	200 mg/l
Average TSS Concentration:	150 mg/l
EFFLUENT REQUIREMENTS	
30 Day Average BOD:	80 mg/l
30 Day Average TSS:	80 mg/l
INFLUENT SCREENS	
Type:	Rotary
No. of Units:	3 (one standby)
Flow per Screen:	900 gpm
Screen Opening:	0.020 inches
Screenings Disposal:	Landfill
BIOLOGICAL ROUGHING FILTERS	
No. of Units:	2
Wetting Rate at Peak Flow:	4 gpm/ft^2
BOD Loading at Peak Flows:	460 lbs/day/100 ft^2
Media:	Plastic Sheet Type
Media Specific Surface Area:	27 ft^2/ft^3
Reactor Diameter:	24 ft
Reactor Height:	20 ft
Recycle Rate:	Not Required
PRIMARY CLARIFIER	
Type:	Circular
No. of Units:	1
Overflow rate at Average Flow:	900 gpd/ft^2
Overflow rate at Peak Flow:	1800 gpd/ft^2
Diameter:	60 ft
Side Water Depth:	12 ft
Sludge Removal:	Continuous Flow
Sludge Concentration:	4%
AEROBIC DIGESTER	
No. of Units:	1
Detention Time at Average Flow:	21 days
Reactor Volume:	178,500 gallons
Design VSS Reduction:	45%
Design Air Requirement:	25 SCFM/1000 ft^3
Total Air Requirement:	600 SCFM
Diffuser Type:	Coarse Bubble
No. of Blowers:	2 (one standby)
Blower Capacity:	600 SCFM
Blower Motor Horsepower:	40 HP

2.5.5.3 Alternative R-2 - Secondary Treatment Process

The wastewater treatment analysis included a fail-safe alternative for a secondary treatment plant, including the capability of permitting and discharging effluent to a receiving water body or Reynolds Metals.

As described in Section 2.5.5.2, the allowable application rate on the tailings beds is uncertain. Application rates based on water balance calculations in accordance with Table 2-21 results in a land area requirement of 783 acres. This required area exceeds the land area available at the Reynolds Sherwin Plant site.

Since the tailings beds are an engineered system with leachate collection, it is likely that higher application rates could be used, thereby decreasing the required land area and corresponding storage volume. It is recommended that column studies be performed in order to determine maximum application rates as it relates to BOD reduction through the tailings beds. Should the column studies show that application rates are not high enough to use only the beds at the Reynolds Sherwin Plant site, the following options are available:

- Pump primary effluent to the tailings beds at the Reynolds Copano Bay Facility.
- Design the regional WWTP to meet advanced secondary treatment standards and discharge effluent to Corpus Christi Bay or for industrial process reuse at Reynolds Metals.

It is likely that a permitted discharge will require an effluent quality of 10 mg/L BOD, 15 mg/L TSS, 3 mg/L NH_3-N and a dissolved oxygen content of at least 4 mg/L.

Several alternative treatment processes are available to meet these criteria. A cost effectiveness analysis of various treatment processes is beyond the scope of this study. Conceptual cost estimates for a "generic" secondary treatment plant are presented in Section 5.0.

2.5.6 Cost Estimates for Wastewater Treatment Alternatives

The evaluation of wastewater treatment alternatives included estimation of all capital and annual O & M costs associated with the regional wastewater treatment system.[3] Descriptions of required facilities and their costs are presented in the following sections. The types, special features and capacities of wastewater pump stations will be determined during final design. Pump stations may be designed as wet pit/dry pit or submersible types, and may include raw screening facilities, odor control facilities and chemical addition facilities, as required. Conceptual cost estimates were prepared based on two possible options:

Option 1: The pump stations sized for a firm pumping capacity of 3Q (average daily flow in year 2020 times a peak factor of 3). Peak wet weather flows in excess of pump station capacities would be diverted to storage facilities for purposes of flow equalization. The flow equalization/storage facilities may consist of new storage tanks or basins, existing WWTP basins that are modified, or a combination of both. Flow equalization/storage facilities would be utilized only during periods of excessive wet weather peaks. Provisions would need to be made for O & M, including cleaning of facilities after their use, to prevent objectionable conditions from forming.

Option 2: Pump stations sized for a firm pumping capacity of approximately 6Q (average daily flow in year 2020 times a peak factor of 6). In order to pump peak flows of 6Q and maintain reasonable head loss and power requirements in the relatively long force mains, a dual force main system is proposed. Advantages of this system include flexibility and reliability based on the dual lines. Disadvantages include higher initial capital costs and the fact that provisions will also be required for cleaning of the standby force main after its use to prevent objectionable conditions from forming.

Schematics, routing maps and cost tables are shown in Appendix C.

2.5.6.1 Phase 1 - Portland

Proposed facilities include:

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[3]Cost estimates are for conveyance of wastewater to the regional wastewater treatment plant and for operations of the plant, which would be located adjacent to the Reynolds Metals property, and do not include costs that Reynolds Metals must incur to accept and use the wastewater at the Reynolds Metals manufacturing plant.

- Piping diversion of existing raw wastewater influent into a new wastewater pump station.

- Raw wastewater pump station at Main WWTP site.

- Flow equalization/storage facilities.

- 16-inch force main from pump station to Regional WWTP.

- Modifications to existing collection system pump stations and force mains that serve the Northshore area.

The cost estimate is based on a 16-inch force main from the Main WWTP to the Regional WWTP. Final design will include evaluation of an alternative to utilize the 12-inch force main (to be constructed by the City of Portland during abandonment of the Northshore WWTP) and construct a new parallel 12-inch force main for a portion of the routing, in lieu of 16-inch force main all the way. Existing pump stations and force mains that serve the Northshore area of Portland will be modified, as required, to manifold into the new force main system that discharges into the Regional WWTP.

Preliminary estimates of total project capital cost and total annual cost for Option 1 are $1.67 million and $289 thousand, respectively (Table 2-23). Capital costs for Option 2 are $2.29 million with annual costs of $352 thousand (Table 2-23).

2.5.6.2 Phase 2 - Gregory

Proposed facilities include:

- Piping diversion of existing raw wastewater influent into a new wastewater pump station (or modification of the existing lift station if possible).

- Raw wastewater pump station at WWTP site.

- Flow equalization/storage facilities.

- 8-inch force main from pump station to regional WWTP.

TABLE 2-23
COST SUMMARY FOR REGIONAL WASTEWATER TREATMENT ALTERNATIVES[*]

Phase and Entity	Capital Cost (Million)	Annual Cost ($1,000)
Phase 1 - Portland - Option 1	$1.67	$289
Phase 1 - Portland - Option 2	2.29	352
Phase 2 - Gregory - Option 1	0.54	103
Phase 2 - Gregory - Option 2	0.69	118
Phase 3 - Aransas Pass - Option 1	2.84	525
Phase 3 - Aransas Pass - Option 2	4.43	688
Phase 3A - Ingleside - Option 1	1.77	330
Phase 3A - Ingleside - Option 2	2.37	391
Phase 3B - Aransas Pass & Ingleside Combined - Option 1	2.67	474
Phase 3B - Aransas Pass & Ingleside Combined - Option 2	4.15	625
Phase 3B - Ingleside Combined with Aransas Pass - Option 1	1.26	227
Phase 3B - Ingleside Combined with Aransas Pass - Option 2	1.75	278
Phase 4 - Taft - Option 1	1.74	276
Phase 4 - Taft - Option 2	2.49	352
Phase 4A - Taft & Sinton Combined - Option 1	1.19	181
Phase 4A - Taft & Sinton Combined - Option 2	1.80	244
Phase 4A - Sinton Combined with Taft - Option 1	2.78	454
Phase 4A - Sinton Combined with Taft - Option 2	4.08	587
Phase 4B - Odem Combined with Sinton & Taft - Option 1	2.05	327
Phase 4B - Odem Combined with Sinton & Taft - Option 2	3.36	461
Regional WWTP -- 2.5 MGD Primary Treatment (R-1)	1.63	312
Regional WWTP -- 5.0 MGD Primary Treatment (R-1)	2.57	488
Regional WWTP -- 2.5 MGD Secondary Treatment (R-2)	4.88	663
Regional WWTP -- 5.0 MGD Secondary Treatment (R-2)	7.52	1,024

[*]Costs are for conveyance of wastewater to the regional wastewater treatment plant and for operations of the plant, which would be located adjacent to the Reynolds Metals property, and do not include costs that Reynolds Metals must incur to accept and use the wasteawter at the Reynolds Metals manufacturing plant.
See Appendix C. Options 1 and 2 are defined at the beginning of Section 2.5.6.

Preliminary estimates of total project capital cost and total annual cost for Option 1 are $543 thousand and $103 thousand, respectively (Table 2-23). Capital costs for Option 2 are $689 thousand with annual costs of $118 thousand (Table 2-23).

2.5.6.3 Phase 3 - Aransas Pass

Proposed facilities include:

- Piping diversion of existing Ransom Island Pump Station raw wastewater influent into a new wastewater pump station.
- Raw wastewater pump station at Ransom Island Pump Station site.
- Flow equalization/storage facilities.
- 16-inch force main from pump station to a repump station located north of Highway 361 northwest of Ingleside.
- Wastewater repump station.
- 16-inch force main from repump station to regional WWTP.

The flow equalization/storage facilities may consist of new storage tanks or basins located at the pump station site or the existing WWTP site, existing WWTP basins that are modified, or a combination of both. Future pump station(s) and force mains to serve the far northwestern portion of the service area may be designed to manifold into the 16-inch force main between the Ransom Island Pump Station and the repump station.

Preliminary estimates of total project capital cost and total annual cost for Options 1 are $2.84 million and $525 thousand, respectively (Table 2-23). For Option 2, capital costs are $4.43 million and annual costs are $688 thousand (Table 2-23).

2.5.6.4 Phase 3A - Ingleside

Proposed facilities include:

- Piping diversion of existing Eighth Street Lift Station raw wastewater influent into a new wastewater pump station (or modification of the existing lift station, if possible).
- Raw wastewater pump station at Eighth Street Pump Station site (located on the WWTP site).
- Flow equalization/storage facilities.
- 12-inch force main from the pump station to a repump station located north of Highway 361 northwest of Ingleside.
- Wastewater repump station.
- 12-inch force main from repump station to regional WWTP.

Preliminary estimates of total project capital cost and total annual cost for Option 1 are $1.77 million and $330 thousand, respectively (Table 2-23). For Option 2, capital costs are $2.37 million and annual costs are $391 thousand (Table 2-23).

2.5.6.5 Phase 3B - Aransas Pass and Ingleside Combined

Proposed facilities were previously listed in Sections 2.5.6.3 and 2.5.6.4, with the exception that the repump station will be sized for the combined flow from the two cities. In addition, the force main from the repump station to the regional WWTP will be increased in size to 20-inch for the combined flow. Estimated project capital costs for Aransas Pass combined with Ingleside for Option 1 are $2.67 million, with annual costs of $474 thousand (Table 2-23); for Option 2, capital costs are $4.15 million and annual costs are $625 thousand (Table 2-23).

Estimated project capital costs for Ingleside combined with Aransas Pass for Option 1 are $1.26 million, with annual costs of $227 thousand (Table 2-23); for Option 2 , capital costs are $1.75 million, with annual costs of $278 thousand (Table 2-23).

2.5.6.6 Phase 4 - Taft

Proposed facilities include:

- Piping diversion of existing Pump Station #3 raw wastewater influent into a new wastewater pump station (or modification of the existing pump station, if possible).
- Raw wastewater pump station at Pump Station #3 site.
- Flow equalization/storage facilities.
- 12-inch force main from pump station to regional WWTP.

The flow equalization/storage facilities will consist of new storage tanks or basins at the Pump Station #3 site. Preliminary estimates of total project capital cost and total annual cost for Option 1 are $1.74 million, and $276 thousand, respectively (Table 2-23). For Option 2, capital costs are $2.49 million, with annual costs of $352 thousand (Table 2-23).

2.5.6.7 Phase 4A - Taft and Sinton Combined

In addition to proposed facilities listed previously for Taft, additional facilities proposed for Sinton include:

- Piping diversion of existing raw wastewater influent into a new wastewater pump station.
- Raw wastewater pump station at WWTP site.
- Flow equalization/storage facilities.
- 12-inch force main from pump station to a repump station located midway between sinton and Taft.
- Wastewater repump station.
- 12-inch force main from repump station to regional pump station in Taft (Taft Pump Station #3).

Preliminary estimates of total project capital cost and total annual cost for Taft Option 1 combined with Sinton are $1.19 million and $181 thousand, respectively (Table 2-23). While for Option 2 capital costs are $1.80 million and annual costs are $244 thousand (Table 2-23). For Sinton, combined with Taft, for Option 1, capital costs are $2.78 million, with annual costs of $454 thousand (Table 2-23); for Option 2, capital costs are $4.08 million with annual costs of $587 thousand (Table 2-23).

2.5.6.8 Phase 4B - Taft, Sinton and Odem Combined

In addition to proposed facilities listed previously for Taft and Sinton, additional facilities proposed for Odem include:

- Piping diversion of existing raw wastewater influent into a new wastewater pump station.
- Raw wastewater pump station at WWTP site.
- Flow equalization/storage facilities.
- 8-inch force main from pump station to new repump station located midway between Odem and Taft.
- Wastewater repump station.
- 8-inch force main from repump station to regional pump station in Taft (Taft Pump Station #3).

Preliminary estimates of total project capital cost and total annual cost for Option 1 are $2.05 million and $327 thousand, respectively (Table 2-23). For Option 2, capital costs are $3.36 million with annual costs of $461 thousand (Table 2-23).

2.5.6.9 Regional WWTP

Preliminary estimates of total project capital cost and total annual cost for 2.5 mgd and 5.0 mgd regional WWTPs (Primary Treatment Alternative R-1) are shown in Appendix C, Tables 21 and 23, respectively. Preliminary estimates for Secondary Treatment Alternative R-2, sized for 2.5 mgd and 5.0 mgd, are shown Appendix C, Tables 22 and 23, respectively. Capital and annual costs for a 2.5 mgd primary treatment plant are $1.63 million and $312 thousand, respectively, with capital and annual costs for a 2.5 mgd secondary treatment plant of $4.88 million and $663 thousand (Table 2-22). Capital costs for a 5.0 mgd primary treatment plant are $7.52 million, with annual costs of $1.02 million (Table 2-22).

2.5.6.10 Northshore Country Club

Scenarios for satisfying Northshore Country Club's irrigation needs were discussed in Section 2.4.1.1.5. Cost summaries of each follow:

<u>Scenarios 1A and 1B</u>

Table 2-24 summarizes the NSCC costs under Scenario 1A, where City of Gregory wastewater treatment plant effluent continues to be discharged to Green Lake.

TABLE 2-24
NSCC WATER DELIVERY COSTS - SCENARIO 1A

Item	Annual Cost	Capital Cost
Water purchased from COP; 79 acft	$26,897	
Modify Green Lake intake/pump	$1,530	$15,000
Irrigation System O&M	$ 20,000	
TOTALS	$48,427	$15,000

Table 2-25 summarizes the NSCC costs under Scenario 1B, where City of Gregory wastewater treatment plant effluent is diverted to the Regional Plant and therefore does not enter Green Lake.

TABLE 2-25
NSCC WATER DELIVERY COSTS - SCENARIO 1B

Item	Annual Cost	Capital Cost
Water purchased from COP; 93 acft	$31,824	
Modify Green Lake intake/pump	$1,530	$15,000
Irrigation System O&M	$18,000	
TOTALS	$51,354	$15,000

Scenario 2

Table 2-26 summarizes the NSCC costs under Scenario 2.

TABLE 2-26
NSCC WATER DELIVERY COSTS - SCENARIO 2

Item	Annual Cost	Capital Cost
Regional primary plant (NSCC share = 20%)	$40,800	$400,000
O&M for regional primary plant (NSCC share = 20%)	$12,000	
Regional secondary plant (NSCC share = 100%)	$76,500	$750,000
O&M for regional secondary plant (NSCC share = 100%)	$20,000	
Pump/pipeline system	$32,640	$320,000
O&M for pump/pipeline	$8,000	
Lined storage pond	$17,340	$170,000
Irrigation piping system modifications	$2,550	$25,000
Water purchased from COP to keep other ponds full; 18 acft	$6,000	
O&M for irrigation system	$20,000	
TOTALS	$235,830	$1,665,000

Scenarios 3A and 3B

Table 2-27 summarizes the NSCC costs under Scenario 3A, where City of Gregory wastewater treatment plant effluent continues to be discharged to Green Lake.

TABLE 2-27
NSCC WATER DELIVERY COSTS - SCENARIO 3A

Item	Annual Cost	Capital Cost
New check dam	$16,830	$165,000
New intake/pump at main body of Green Lake	$5,100	$50,000
O&M for above	$5,000	
Water purchased from COP; 22 acft	$7,528	
O&M for irrigation system	$20,000	
TOTALS	$54,458	$215,000

Table 2-28 summarizes the NSCC costs under Scenario 3B, where City of Gregory wastewater treatment plant effluent is diverted to the Regional Plant and therefore does not enter Green Lake.

TABLE 2-28
NSCC WATER DELIVERY COSTS - SCENARIO 3B

Item	Annual Cost	Capital Cost
New check dam	$16,830	$165,000
New intake/pump at main body of Green Lake	$5,100	$50,000
O&M for above	$5,000	
Water purchased from COP; 31 acft	$10,608	
O&M for irrigation system	$18,000	
TOTALS	$55,538	$215,000

Scenarios 4A and 4B

Table 2-29 summarizes the NSCC costs under Scenario 4A, where City of Gregory wastewater treatment plant effluent continues to be discharged to Green Lake.

TABLE 2-29
NSCC WATER DELIVERY COSTS - SCENARIO 4A

Item	Annual Cost	Capital Cost
Water purchased from SPMWD; 79 acft	$8,110	
Modify Green Lake intake/pump	$1,530	$15,000
Irrigation System O&M	$ 20,000	
TOTALS	$29,640	$15,000

Table 2-30 summarizes the NSCC costs under Scenario 4B, where City of Gregory wastewater treatment plant effluent is diverted to the Regional Plant and therefore does not enter Green Lake.

TABLE 2-30
NSCC WATER DELIVERY COSTS - SCENARIO 4B

Item	Annual Cost	Capital Cost
Water purchased from SPMWD; 93 acft	$9,547	
Modify Green Lake intake/pump	$1,530	$15,000
Irrigation System O&M	$18,000	
TOTALS	$29,077	$15,000

2.5.7 Economic Feasibility of Wastewater Treatment Alternatives

Evaluation of the economic feasibility of the regional wastewater treatment system was based on the following assumptions:

- The total cost to each city for regional treatment would not exceed the existing cost of treatment with its own individual WWTP.

- Regional costs to be borne by each city include the cost to transport its untreated wastewater to the regional WWTP and a share of regional WWTP debt service and O & M costs, based on the contribution of flow as a percentage of the total flow.

Existing treatment costs for each city include:

- Outstanding annual debt service on existing treatment facilities.

- Annual O & M costs for existing treatment facilities (inflation costs were not considered in the evaluation).

Cost information for the above items was provided by each city. The following additional annual costs were considered in calculation of the overall total existing cost of treatment for each city:

- Annual maintenance reserves to fund estimated equipment replacement/repair costs at the end of approximately 20 years of equipment life. (Future equipment replacement/repair cost may vary substantially, depending upon a number of factors, including: extent of routine maintenance performed on the equipment; type of treatment process; and quality of existing equipment. Costs were estimated by using "rule of thumb" treatment costs, based on data from past projects, and applying engineering judgement to determine the percentage of major equipment costs to total facility cost. For purposes of this evaluation, the estimated total equipment replacement/repair cost was spread evenly over a number of years in order to build a maintenance reserve for funding the work at the end of the equipment's 20-year life.)

- Annual debt service to fund future plant upgrades required to meet more stringent effluent limitations required at permit renewal. (Costs were estimated conservatively low by using a factor of $0.10 per gallon of plant capacity.)

- Annual debt service and O & M costs for known plant improvements that are required (i.e., UV disinfection facilities required at Portland and Aransas Pass, etc.).

The above costs were tabulated in an annual cash flow format through the year 2020 for each city.

Annual cash flow projections were then prepared for each city using the following scenarios:

- Abandon existing individual WWTP and connect to regional treatment system as early as possible.
- Abandon existing individual WWTP and connect to regional treatment system after existing debt service is retired.
- Where applicable, cash flow projections for the above two scenarios were also prepared for feasible combinations of cities (i.e., Aransas Pass and Ingleside combined; Taft and Sinton combined; Taft, Sinton and Odem combined).

Cash flow projections for the above scenarios included the following annual costs and annual revenue:

<u>Annual Cost to City (Existing treatment facilities and proposed wastewater transmission facilities)</u>

- Annual debt service to be retired on existing treatment facilities, if it extends beyond the year the City connects to the regional treatment system.
- Annual debt service on proposed facilities required to transport untreated wastewater from each city to the regional WWTP.
- Annual O & M costs for proposed facilities required to transport untreated wastewater from each city to the regional WWTP.
- Annual debt service and O & M costs for known plant improvements that are required. (It is assumed that improvements such as UV disinfection facilities will be required at Portland and Aransas Pass if connection to the regional WWTP is not made for several years.

Note: Costs for unscheduled mechanical repairs or replacement, unforeseen labor and operations increases, environmental liability, increased monitoring costs, and future plant improvements that could potentially be required to meet more stringent discharge requirements were not included in the annual costs to cities. In addition, inflation costs were not considered in the evaluation.

Annual Revenue Available to City

- Amount equivalent to the total annual cost tabulated for each city's existing WWTP.
- Annual revenue generated through the sale of treated effluent (based on per capita flows calculated in Section 2.1.3.1, population projections for the year 2000, and a value of treated effluent of $0.40/1000 gallons). Inflation was not considered in the evaluation.

The amount of funds available to pay each city's share of annual debt service and O & M costs for the regional WWTP was calculated by adding all annual costs for each city and deducting the total from the annual revenue available to each city.

The cash flow projections are summarized for each city and combinations of cities in the following sections. A benefit-cost evaluation, together with a recommended regional plan is shown in Section 7.2.

2.5.7.1 Phase 1 - Portland

The annual cash flow for Portland's existing WWTP is shown in Appendix D - Table 1. The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2 are summarized below:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Portland	$170,000	$119,000	C-1
2	Portland	$233,000	$119,000	C-2

The costs for Option 1 were utilized in annual cash flow calculations (connection to the regional WWTP system in 1997) and resulted in an annual revenue available for regional WWTP debt service and O & M costs that varies between $198,000 and $343,000 during the period from 1997 - 2020 (Appendix D - Table 2)[4]. Option 1 costs utilized in annual cash flow calculations (connection to regional WWTP system in 2000) resulted in an annual revenue available for regional WWTP debt service and O & M costs that ranges between $173,000 and $225,000 during the period from 2000 - 2020 (Appendix D - Table 3).

2.5.7.2 Phase 2 - Gregory

The annual cash flow for Gregory's existing WWTP is shown in Appendix D - Table 4. The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2 are summarized as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Gregory	$55,000	$48,000	C-3
2	Gregory	$70,000	$48,000	C-4

The costs for Option 1 were utilized in annual cash flow calculations (connection to regional WWTP system in 1997) and resulted in an annual revenue available for regional WWTP debt service and O & M costs that varies between $34,000 and $89,000 during the period from 1997 - 2020 (Appendix D - Table 5). Option 1 costs utilized in annual cash flow calculations (connection to regional WWTP system in 2002) resulted in an annual revenue available for regional WWTP debt service and O & M costs of $34,000 for the period from 2002 - 2020 (Appendix D - Table 6).

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[4]Only Option 1 described in Section 2.5.6 was evaluated in the cash flow analyses, since Option 2 had a higher cost for all cities.

2.5.7.3 Phase 3 - Aransas Pass

The annual cash flow for the Aransas Pass WWTP is shown in Appendix D - Table 7. The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2 are summarized as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Aransas Pass	$289,000	$236,000	C-5
2	Aransas Pass	$452,000	$236,000	C-6

The costs for Option 1 were utilized in annual cash flow Appendix D - Table 8 (connection to regional WWTP system in 1997) and resulted in an annual revenue available for regional WWTP debt service and O & M costs that varies between $32,000 and $181,000 during the periods from 1997 - 2001 and 2017 - 2020. However, during the period from 2002 - 2016, the City's debt service and O & M costs to transport untreated wastewater to the regional system exceed the available annual revenue.

2.5.7.4 Phase 3A - Ingleside

The annual cash flow for Ingleside's existing WWTP is shown in Appendix D - Table 10. The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2 are summarized as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Ingleside	$180,000	$150,000	C-7
2	Ingleside	$241,000	$150,000	C-8

The costs for Option 1 were utilized in annual cash flow Appendix D - Table 11 (connection to regional WWTP system in 1997). During the entire period from 1997 - 2020, the City's debt service and O & M costs to transport untreated wastewater to the regional system and its existing debt service, exceed the available annual revenue. An annual cash flow table was also prepared to show the cash flow for the scenario of Ingleside connections to the regional system after its existing debt service is retired in 2005 (Appendix D - Table 12).

2.5.7.5 Phase 3B - Aransas Pass and Ingleside Combined

The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2, if untreated wastewater from Aransas Pass and Ingleside are combined, are summarized as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Aransas Pass	$272,000	$202,000	C-9
2	Aransas Pass	$423,000	$202,000	C-10
1	Ingleside	$128,000	$99,000	C-11
2	Ingleside	$179,000	$99,000	C-12

The costs for Option 1 were utilized in annual cash flow Appendix D - Table 13 (Aransas Pass - connection to regional WWTP system in 1997) and Appendix D - Table 14 (Ingleside - connection to regional WWTP system in 1997), and resulted in the following annual revenues available for regional WWTP debt service and O & M costs:

- Aransas Pass annual revenue varied between $45,000 and $215,000 for the periods from 1997 - 2013 and 2017 - 2020. However, during the period from 2014 - 2016, the City's debt service and O & M costs to transport untreated wastewater to the regional system exceed the available annual revenue.

- Ingleside annual revenue varied between $33,000 and $51,000 for the period from 1997 - 2020.

Appendix D - Table 9 shows the scenario of Aransas Pass connecting to the regional system in 2000. Appendix D - Table 16 shows the scenario of Aransas Pass combined with Ingleside and connecting to the regional system after its existing debt service is retired in 2000. Appendix D - Table 17 shows the scenario of Ingleside combined with Aransas Pass and connecting to the regional system after its existing debt service is retired in 2005.

2.5.7.6 Phase 4 - Taft

The annual cash flow for Taft's existing WWTP is shown in Appendix D - Table 18. The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2 are summarized as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Taft	$178,000	$98,000	C-13
2	Taft	$254,000	$98,000	C-14

The costs for Option 1 were utilized in annual cash flow Appendix D - Table 19 (connection to regional WWTP system in 1998). During the period from 1998 - 2017, the City's debt service and O & M costs to transport untreated wastewater to the regional system exceed the available annual revenue.

2.5.7.7 Phase 4A - Taft and Sinton Combined

The annual cash flow for Sinton's existing WWTP is shown in Appendix D - Table 21.

The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2, if untreated wastewater from Taft and Sinton are combined, are summarized as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Taft	$121,000	$60,000	C-15
2	Taft	$184,000	$60,000	C-16
1	Sinton	$283,000	$171,000	C-17
2	Sinton	$416,000	$171,000	C-18

The costs for Option 1 were utilized in annual cash flow Appendix D - Table 20 (Taft - connection to regional WWTP system in 1998) and Appendix D - Table 22 (Sinton - connection to regional WWTP system in 1998), and resulted in the following:

- Taft annual revenue was $19,000 for the period from 1998 - 2002. However, during the period from 2003 - 2017, the City's debt service and O & M costs to transport untreated wastewater to the regional system exceed the available annual revenue.
- During the period from 1998 - 2016, Sinton's debt service and O & M costs to transport untreated wastewater to the regional system exceed the available annual revenue.

2.5.7.8 Phase 4 B - Odem, Taft and Sinton Combined

The annual cash flow for Odem's existing WWTP is shown in Appendix D - Table 23. The total annual costs of wastewater pumping and transmission facilities for Options 1 and 2, if untreated wastewater from Odem, Taft and Sinton are combined, are as follows:

Option	City	Annual Debt Service	Annual O & M	Reference Appendix Table
1	Odem	$209,000	$118,000	C-19
2	Odem	$343,000	$118,000	C-20

The costs for Option 1 were utilized in annual cash flow Appendix D - Table 24 (connection to regional WWTP system in 1998). During the entire period from 1998 - 2020, the City's debt service and O & M costs to transport untreated wastewater to the regional system exceed the available annual revenue.

2.6 Evaluation of Environmental Impacts of Effluent Diversions

2.6.1 Portland Main WWTP

Discharge from the Portland Main WWTP is projected to be approximately 1.33 mgd in 1997 and 1.65 mgd in 2020. Based on a typical nitrogen concentration of 5 mg/L in the effluent, the input of nitrogen into Nueces Bay from this discharge is approximately 25 Kg/day. The daily input rate is less than three percent of the combined nitrogen inputs from the Nueces River, industrial discharge and mean direct precipitation, which totals approximately 963 Kg/day. If the wastewater discharge is discontinued, the quantity of nitrogen lost to the bay would not significantly alter the nitrogen budget of Nueces Bay.

Hydrographic data collected monthly from May, 1990 to December, 1993 confirms that the concentrations of salinity, nitrate and ammonium at the sampling site near the Portland WWTP discharge point had mean values of 27.9 parts per thousand (ppt), 1.3 umole/1 and 2.1 umole/1 respectively and did not differ from a site near the Nueces Bay Causeway about two miles away. During the year of 1990, the chlorophyll values near the treatment plant had a mean value of

13.8 ug/l compared to 9.9 ug/l near the causeway. This small enhanced concentration resulted from the phytoplankton bloom during a 3-month period in the spring while the remaining months of the year the two stations registered the same values. Since this was a short-lived spring bloom, it is not considered to result from the discharge of the Portland WWTP which releases approximately the same quantity of material throughout the entire year. Rather, the observed increase in chlorophyll concentration is probably due to circulation patterns within the bay. The embayment of Nueces Bay near the City of Portland appears to have a reduced amount of water circulation compared to other parts of Nueces Bay, as deduced from the distribution of dissolved conservative properties such as salinity. This reduced circulation would tend to concentrate the phytoplankton cells to produce the observed increase in chlorophyll concentration.

2.6.2 Aransas Pass WWTP

The projected discharge of the Aransas Pass WWTP is 1.01 mgd in 1997 and 1.36 mgd in the year 2020. The estimated input of nitrogen into Redfish Bay would be about 20 Kg/day which would have an even smaller productivity impact than the Portland WWTP discharge, as explained in Section 2.6.1. This discharge does not influence the productivity of plankton in Redfish Bay, however, some local growth of freshwater marsh plants may become established in the nearby mixing zone of the effluent.

2.6.3 Ingleside, Gregory, Taft, Sinton and Odem WWTPs

The effluent disposal in open ditches by Ingleside (0.73 mgd), Gregory (0.32 mgd), Taft (0.58 mgd), Sinton (0.61 mgd), and Odem (0.24 mgd) does not support any visible wetland vegetation, therefore the effluent does not appear to be vital to the maintenance of estuarine habitat. The 1997 estimated discharge rates are about 25 to 50 percent as large as the Portland WWTP discharge rates so the estimated impact on plankton productivity would be less than two percent of the other anthropogenic and natural inputs. The effluents from these WWTPs would have a much more significant impact if they were combined to produce a quantity of about 2.5 mgd, and then the water and nutrients were discharged into a well defined setting to produce a significant and positive environmental response.

2.6.4 Additional Environmental Impacts

In addition to the impacts on Nueces Bay quality and productivity, other potential environmental impacts will need to be addressed prior to implementation of proposed effluent or raw wastewater diversions. These impacts will include both direct (construction related) and indirect (growth related) and may include impacts to wetlands, waterfowl habitat, and archeological sites. Future design phases for projects identified in this planning study will include full environmental assessments conducted in accordance with applicable regulatory requirements.

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3.0 ALTERNATIVE FLOOD MANAGEMENT PLANS FOR THE GREEN LAKE OUTFALL SYSTEM

The past history of development and operation of the Green Lake outfall system has resulted in numerous studies addressing drainage issues in the area. As stated in Section 2, the Green Lake system serves the following roles, in addition to its primary function as a major drainage outfall:

- Outfall for effluent from Gregory's WWTP and Portland's Northshore WWTP.
- Impoundment for supply of irrigation water to Northshore Country Club (NSCC).

The primary objective of this section of the report is to evaluate the potential of developing a flood management plan for the Green Lake outfall system which will reduce flood elevations in portions of Gregory and unincorporated areas of the county.

3.1 Existing Studies Addressing Drainage and Flood Control Problems Associated with Green Lake Dam Outfall

Several studies performed for the Green Lake area and available design plans for drainage and flood control improvements associated with the Green Lake outfall system and tributary drainage systems were reviewed. In addition, information provided by the San Patricio County Drainage District (SPCDD) and hydrologic and hydraulic models previously developed for the area were utilized to assist with this analysis and evaluation of flooding and drainage problems related to the Green Lake outfall system. As part of the review, the Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS) and the July, 1987 Flood Control Study for San Patricio County, Texas (1987 Flood Study) were also used to provide information on previously calculated peak discharge values, computed water surface profiles and delineated flood plain boundaries. See Appendix A for a list of references reviewed. Selected studies are summarized as follows.

3.1.1 Federal Emergency Management Agency (FEMA) Flood Insurance Studies

In 1968 Congress passed the National Flood Insurance Act and created the National Flood Insurance program (NFIP). The Program is administered by FEMA. Flood Insurance Studies (FIS) are special hydrologic and hydraulic studies which are undertaken and periodically updated by FEMA for communities participating in the NFIP. Detailed studies are generally performed for developed areas, whereas approximate information is generally provided for undeveloped areas. The FIS's performed for the Green Lake area include the City of Gregory, the City of Portland, and unincorporated areas of San Patricio County.

3.1.1.1 Flood Insurance Study - City of Gregory, San Patricio County, Texas

The City of Gregory, FIS, completed in 1980, describes Gregory as having very flat topography with a common elevation of approximately 30 feet - National Geodetic Vertical Datum (NGVD), and black clay soils with low permeability rates. The study states that Gregory is situated along the border of both the Green Lake and Chiltipin Creek watersheds, and has no natural streams or creeks flowing near or through the City. The Green Lake Channel is described as Gregory's major channel that receives treated wastewater discharged from the City's WWTP and also serves as an outfall for other drainage ditches. The FIS flood discharges were computed using the USGS Open File Report 77-110 "Technique for Estimating the Magnitude and Frequency of Floods in Texas," a regional method based on regression analyses. The study found the drainage area at the mouth of the Green Lake ditch to be 7.72 square miles with a peak 100-year discharge of approximately 1,770 cfs. In the FIS study, hydraulic analyses were performed using the Corp of Engineers (COE) HEC-2 computer program. Starting water surface elevations were calculated using the slope area method and water surface profiles were produced showing the computed water surface elevations for the 10-year, 50-year, 100-year, and 500-year floods. The study shows the 100-year computed water surface elevation at Sunset Road located in south-central Gregory to be approximately 31.4 feet-msl. Areas affected by the 100-year and 500-year flood were delineated to produce a Flood Boundary and Floodway Map and a Flood Insurance Rate Map by using the calculated top width (TOPWID) and the computed water surface elevation at each cross section. Top widths between cross sections were interpolated using the computed water surface profiles and USGS topographic maps. The study found flooding problems for the City of Gregory to be influenced by a combination of factors, however, the FIS describes the major flood hazard for Gregory as being the inadequate capacity of the Green Lake Channel to serve as primary drainage for the City. The FIS also states that the Green Lake Dam, with a top of dam of approximately 26 feet above mean sea level (MSL), also contributes to flooding in the area.

3.1.1.2 Flood Insurance Study - City of Portland, Texas, San Patricio and Nueces Counties

The City of Portland, FIS, completed in 1985, included hydrologic, hydraulic, and wave height analyses using methods developed by Tetra Tech, Inc. The FIS describes Portland's waterfront as a high clay bluff standing 30 to 40 feet (above msl). Beyond the bluff, the topography increases at a rate of two feet per mile ranging from elevations 30 to 40 feet above msl within the City of Portland. The soils within Portland are described as thick clay beds overlain by 6 to 24 inches of clayey to semi-fine sands. As with Gregory, no natural streams flow through Portland, but several major drainage ditches have been constructed.

The hydrologic analyses established peak surge-frequency relationships for the 10-year, 50-year, 100-year, and 500-year floods. The procedures utilized to determine tidal surge-elevation relationships for the shoreline were based on joint probability methods that utilized historical data of individual storm parameters. The Tetra Tech methodology for hydraulic analyses utilized an overland propagation model (SURGEOD) to determine inland surge heights and flooding limits.

The FIS states that, due to the flat topography and the low permeability soils, storm runoff tends to pond, increasing flooding in Portland. A flood insurance rate map (FIRM) was developed utilizing information obtained from the FIS.

3.1.1.3 Flood Insurance Study - San Patricio County, Texas Unincorporated Areas

The study area includes a large area of land that was not addressed in either the Gregory or Portland FEMA Reports. This area was addressed in the unincorporated San Patricio County Study and includes the majority of the Green Lake outfall system.

The FIS for the unincorporated areas of San Patricio County, completed in 1984, describes the topography of San Patricio County as generally flat with elevations ranging from sea level to 150 feet-msl. This study utilized both the "Technique for Estimating the Magnitude and Frequency of Floods in Texas," used in the City of Gregory FIS, and the Tetra Tech methodology, used in the City of Portland FIS. The hydraulic analysis also used the COE HEC-2 and the SURGEOD modeling techniques previously mentioned in the FIS for the City of Portland and the City of Gregory. Computed water surface profiles, Flood Boundary and Floodway Maps, and FIRMs were produced as a result of the FIS.

3.1.2 1987 Flood Control Study - San Patricio County, Texas

In anticipation of the continued growth of San Patricio County and the fact that the area had experienced frequent and severe flooding in the past, the San Patricio County Drainage District (SPCDD) took a major step towards flood control and management on a consistent, county-wide basis in 1986 by authorizing a flood control study. The July 1987 Flood Control Study for San Patricio County, Texas was funded by a grant from the Texas Water Development Board (TWDB) and by the SPCDD. The study was prepared by HDR Infrastructure (now HDR Engineering, Inc.) (HDR) and Naismith Engineering, Inc. (NEI) to assist the SPCDD in developing a flood control and management program. The primary objectives of the Flood Control study were to assess the magnitude and causes of specific flooding problems affecting incorporated communities and rural areas within San Patricio County and to evaluate alternative means of resolving these problems from both an engineering and an economic perspective.

The key objectives of the Flood Control Study were met by a three phase approach. The first phase involved identification of specific flooding problems, data collection, and selection of appropriate hydrologic and hydraulic design criteria. In the second phase, alternative flood control measures were evaluated to resolve specific flooding problems identified in the first phase. Aerial floodplain boundary maps, channel and water surface profiles, computer models, a Drainage Criteria and Design Manual, and a comprehensive report were prepared in the third phase.

The Flood Control Study found that San Patricio County is susceptible to three major causes of flooding which also relate to specific conditions found in the Green Lake drainage basin. One cause is backwater from the defined drainageways and creeks due to inadequate channel capacity, restrictions within the channels, and structures with inadequate capacity to pass storm water flows. The second major cause of flooding identified in the study is the relatively flat topography within the County. As with the FIS's, the Flood Control Study states that water tends to pond and then drain off, infiltrate or evaporate very slowly during and after storm events. Therefore, a large area may have water slowly moving across it in a sheet flow pattern, rather than in defined drainageways. This problem is aggravated by the fact that the soils have a low permeability rate allowing little water to percolate into the ground. The third major cause of flooding mentioned, but not included in the study, is from tidal sources. Tidal sources are not considered in this Green Lake Flood Control evaluation since they do not affect the Green Lake outfall system being studied.

3.1.2.1 Hydrologic Methodology Evaluated in the 1987 Flood Control Study

The 1987 Flood Control Study evaluated methods previously used in San Patricio County to calculate peak runoff for drainage design considerations. The primary method previously used in San Patricio County for the estimation of peak discharge for various return periods in larger watersheds was a set of regionalized equations developed by the U.S. Geological Survey (USGS). These equations were utilized in the performance of the FIS for the County unincorporated areas and the Cities of Sinton, Odem, and Gregory and have been employed by the Texas Department of Transportation (TxDOT) in the hydrologic design of bridges and highway drainage works.

The USGS method presented in Technique for Estimating the Magnitude and Frequency of Floods in Texas is based on multiple regression analyses incorporating annual peak discharge data from 289 gages located throughout the State. Independent variables considered included drainage area, slope, channel length, mean annual precipitation, evaporation, and the 2-year, 24-

hour rainfall intensity. The State was sub-divided into six regions on the basis of the distribution of the residuals from a single statewide regression of the 10-year flood. Most of San Patricio County falls into Flood-Frequency Region 1 as delineated by the USGS. Historically, the County has used the Region 1 equations for the estimation of peak runoff rates. The County is, however, located immediately adjacent to Flood-Frequency Region 2. In both regions, the only independent variables found to be significant at the 95 percent confidence level were slope and drainage area.

For comparison purposes, the Flood Control Study applied the Region 1 and 2 equations to the Chiltipin Creek watershed. This was the only watershed in the area for which a sequence of unregulated historical peak discharge measurements were available. The resulting peak discharge estimates were plotted versus return period along with the three greatest peak discharges observed since 1910. In addition, the flood flow frequency estimation procedure, Guidelines for Determining Flood Flow Frequency, developed by the U.S. Water Resources Council (WRC) and updated, extended, and republished by the USGS were applied to the Chiltipin Creek data. The WRC procedure is a statistically based methodology using the sample statistics of the logarithms of historical annual maximum discharges and frequency factors (Log Pearson Type III) which vary with weighted skew and return period. Peak discharge estimates for return periods ranging from 2 to 100 years computed using the WRC procedure were also plotted along with the 95 percent confidence limits.

The Flood Control Study found it evident that each of the historical maxima were well in excess of that estimated using the Region 1 equations, while agreement with the Region 2 equations was excellent. Peak discharge estimates computed by the WRC procedure were reasonable when compared with the historical events and appear to confirm the applicability of the USGS Region 2 equations. On the basis of these comparisons, the Flood Control Study showed that continued use of the Region 1 equations could have perpetuated underestimation of peak runoff rates by more than 56 percent. The San Patricio County Drainage Criteria and Design Manual recommends that Region 2 equations be used to determine peak runoff rates. Therefore, the peak discharge estimates derived from the USGS Region 1 equations were rejected for use in the study, as they lie partially outside the lower 95 percent confidence limit evaluated for the WRC curve.

3.1.2.2 Alternatives Evaluated in the 1987 Flood Control Study

The second phase of the 1987 Flood Control Study involved evaluating various flood control measures to resolve flooding problems identified for each specific area or community. Peak discharge estimates were computed and hydraulic analyses of the flood control alternatives were performed using the HEC-2 computer program. The flood control solutions included both structural and non-structural measures, and were evaluated by estimating annual flood damage and emergency cost reduction benefits as well as property value enhancements, and comparing them to annual costs of implementation and maintenance of these flood control improvements. The Green Lake outfall system being investigated is discussed in two sections of the 1987 Flood Control Study: the Portland Area, and the Portland/Gregory Area. The discussions are summarized as follows:

3.1.2.2.1 Portland Area

Improvements evaluated for the Portland Area included the construction of a tributary from the Green Lake watershed which would outfall to Gum Hollow approximately 3,500 feet upstream of FM 893. The study states that removal of this area from the Green Lake watershed could result in reducing peak discharge along the main Green Lake Channel (Main BG-00) through Gregory and at Green Lake. A small channel west of the Hunt Airport and extending north to Lang Road was also evaluated and found to reduce the peak discharge in the existing Green Lake and Doyle Addition watersheds. Another improvement evaluated for the Portland Area was the extension of the Doyle Addition Ditch to provide primary outfall drainage to the developing area near the intersection of Lang Road and CR 81. The drainage improvements north of the Doyle Addition and the Hunt Airport are included in the "Comprehensive Plan Summary" for the City of Portland.

An economic evaluation of the recommended improvements showed that the benefit-cost ratio for the project was quite low; i.e., the benefits were low in relation to the costs, since damages to existing development in the area was low, and future development for the area was not expected at the time of the 1987 study. The study did state that improvements in Gum Hollow could slightly reduce flood damage and enhance property values in the Green Lake watershed, however, these benefits were considered marginal. Future development of these projects will contribute to local drainage improvement as the area develops, but will have very little impact on the Green Lake watershed.

3.1.2.2.2 Portland/Gregory Area

Concerns with regard to the performance of Green Lake and its tributary channels including the Oakridge Ditch were addressed in the Portland/Gregory Area section of the 1987 Flood Control Study. The study attributed frequent flooding in the area to the lack of topographic relief, the limited Green Lake spillway capacity, and to the inadequate capacity of both the primary outfall channel and the existing channel structures.

At the time of the 1987 Flood Control Study, plans to modify the hydraulic capacity of the Green Lake Spillway had been prepared by NEI and partial improvements were completed in 1986. Two alternative improvement scenarios for the Green Lake system were evaluated. Alternative 1 considered channel and structural improvements to the Green Lake Channel. Alternative 2 also considered channel and structural improvements to the Green Lake Channel but included a bypass diversion channel around Green Lake along the private road adjacent to Reynolds Metals Company. Finally, improvements to the Oakridge Ditch and Green Lake tributaries (BG-02 and BG-03) along with the extension of Green Lake Channel from FM 2986 to CR 72 were also considered. The proposed improvements were evaluated assuming the Green Lake watershed had been reduced by the tributary diversion channels proposed in the Portland Area section of the study. The HEC-2 computer program was used to analyze models of the existing Green Lake "as is" conditions and of the proposed improvements. The improvements proposed for each scenario were selected to attain a comparable 100-year water elevation or level of protection in the Gregory area. An economic evaluation in the form of a benefit-cost analysis was performed for both scenarios and found the diversion channel bypassing Green Lake to be the least cost effective alternative. Information provided by the 1987 Flood Control Study including the alternatives evaluated, peak discharge values, HEC-2 computer models, and computed water surface profiles were utilized in this study to assist with the analysis of the Green Lake outfall system.

3.2 Operational History of Green Lake System

Drainage and flooding problems related to the Green Lake outfall system have existed for many years. Inadequate capacity of the primary outfall channel and the structural and hydraulic capacity of the dam itself contribute to frequent flooding of the area located between the cities of Gregory and Portland, including the southwestern portions of the City of Gregory.

The relatively flat topography and low permeability soils of San Patricio County contribute to ponding and the slow drainage of the basin. The lack of defined drainage channels also contributes to flooding. The Green Lake Channel was constructed to provide drainage relief to the agricultural crop lands that existed within the area. Stormwater flows through the manmade channel have caused erosion of the surrounding farm land.

The Green Lake outfall structure was originally constructed by K.F. Hunt Construction Company without formal design plans in the 1940's to eliminate the severe erosion. The spillway was constructed to an elevation of approximately 22.36 feet-msl with a top of bank at approximately 29.0 feet-msl. During the 1970's and early 1980's, Northshore Development Corporation, located primarily on the western banks of Green Lake, secured TWC Permit No. 4235 issued on June 10, 1985 authorizing use of stored surface waters for irrigation of its newly constructed golf course and homesite development.

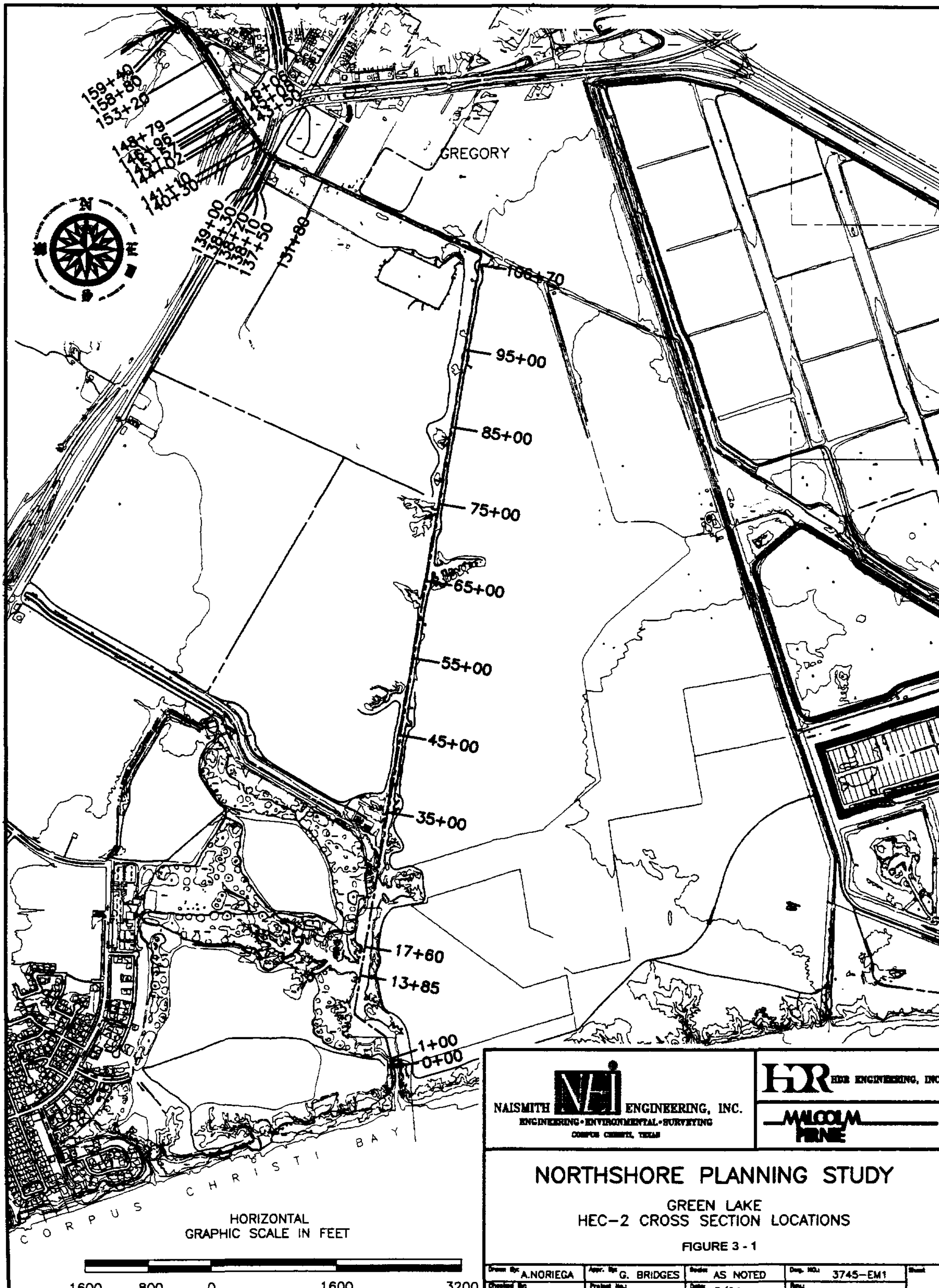
The San Patricio County Drainage District (SPCDD) was formed in 1971 as a drainage maintenance functioning agency. The SPCDD is authorized and empowered to construct, purchase, acquire, own, maintain, and operate drains and drainage facilities. In 1983 structural failures were noticed in portions of the Green Lake Dam, including the existing 48-inch diameter concrete spillway pipes. On December 1, 1983, the SPCDD authorized a structural inspection of the dam by McClelland Engineers, Inc. (MEI). The principal findings of the inspection included six deficiencies in the structure. The deficiencies were: (1) Undermining of the apron around the drop inlets; (2) Undermining of the discharge apron; (3) Inadequate geometric design of the discharge apron; (4) Failed and inadequate wing walls adjacent to the discharge apron; (5) Possible inadequate support of the downstream retaining wall; and (6) Overstressed and broken conduits. MEI recommended rehabilitating the existing dam by removing the upstream apron and filling the eroded channels along the drop inlets with a thick portland cement grout. MEI also recommended that steps be taken to strengthen the retaining wall, for example adding new ties to the top and bottom of the wall to restrain it against lateral forces. Filling the conduits and drop inlets with non-shrink grout, lean non-shrink concrete, or pressure grouting steel liners was also suggested. MEI also advised the removal and replacement of the downstream apron and wing walls. MEI suggested that the wing walls should have drainage layers placed against the natural soils that are capable of removing all seepage and filtering out soil particles that may be eroding from the soil.

In 1984, representatives from the SPCDD, Cities of Portland and Gregory, and representatives of Northshore Development Corp. discussed needed repair work. Plans to modify the hydraulic capacity of the Green Lake spillway were prepared by NEI. All parties agreed to lower the spillway as a part of the recommended repairs and partial improvements to the Green Lake Dam spillway, funded by the SPCDD, were completed in 1986. The improvements completed totalled $ 61,479 and included modification to the spillway by lowering the existing spillway elevation from approximately 22.36 feet-msl to approximately 20.5 feet-msl to enhance the hydraulic efficiency of the structure. The project also involved rehabilitating the existing spillway (10- to 48-inch diameter non-reinforced concrete culverts) by lining the old pipe with new 42-inch corrugated metal pipe and grouting the new pipe in place. The improvements also included modifications to the inlet structure to increase the hydraulic efficiency of the inlet control conditions.

3.3 Drainage and Flood Control Infrastructure

Green Lake Channel and it's tributary system are located in San Patricio County in the area south of Gregory and east of Portland (Figure 3-1). The tributary system includes the Oakridge Ditch, the Cemetery Ditch at station 131+80 (Figure 3-1), and the Gregory Wastewater Treatment Plant Ditch. For purposes of this analysis, the Green Lake outfall system has been divided into three segments. The upstream portion of Green Lake Channel is considered to be the portion of the channel prior to turning to flow south (Stations 159+40 to 106+70). The main portion of the channel is considered to be from the bend in the channel to the lake (Stations 106+70 to 35+00). The downstream lake portion, including the Green Lake spillway, extends from Station 35+00 to 0+00.

The Green Lake drainage basin is divided into seven sub-basins with a total of approximately 10.95 square miles of area upstream of the spillway structure. The soils in the vicinity of the Green Lake Channel consist of nearly level, dark gray clay loams with slow permeability rates and surface runoff ranging from slow to ponded. Review of 1951 topographic maps obtained from Reynolds Metals Company reveals the natural drainage pattern for the area to flow across the relatively flat topography of the basin from the northwest to the southeast. Drainage relief for the area was provided by the manmade Green Lake Channel and the La Quinta Drainage Channel. The Reynolds Metals maps also show the La Quinta Channel to be located on what is currently Reynolds Metals property. The La Quinta Channel has since been diverted to approximately 1,500 feet west of its original location. Recently the SPCDD prepared one-foot aerial photogrammetric mapping of the area. These maps show current basin topography and drainage patterns. A drainage basin map was prepared using the one-foot



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NORTHSHORE PLANNING STUDY

GREEN LAKE
HEC-2 CROSS SECTION LOCATIONS

FIGURE 3 - 1

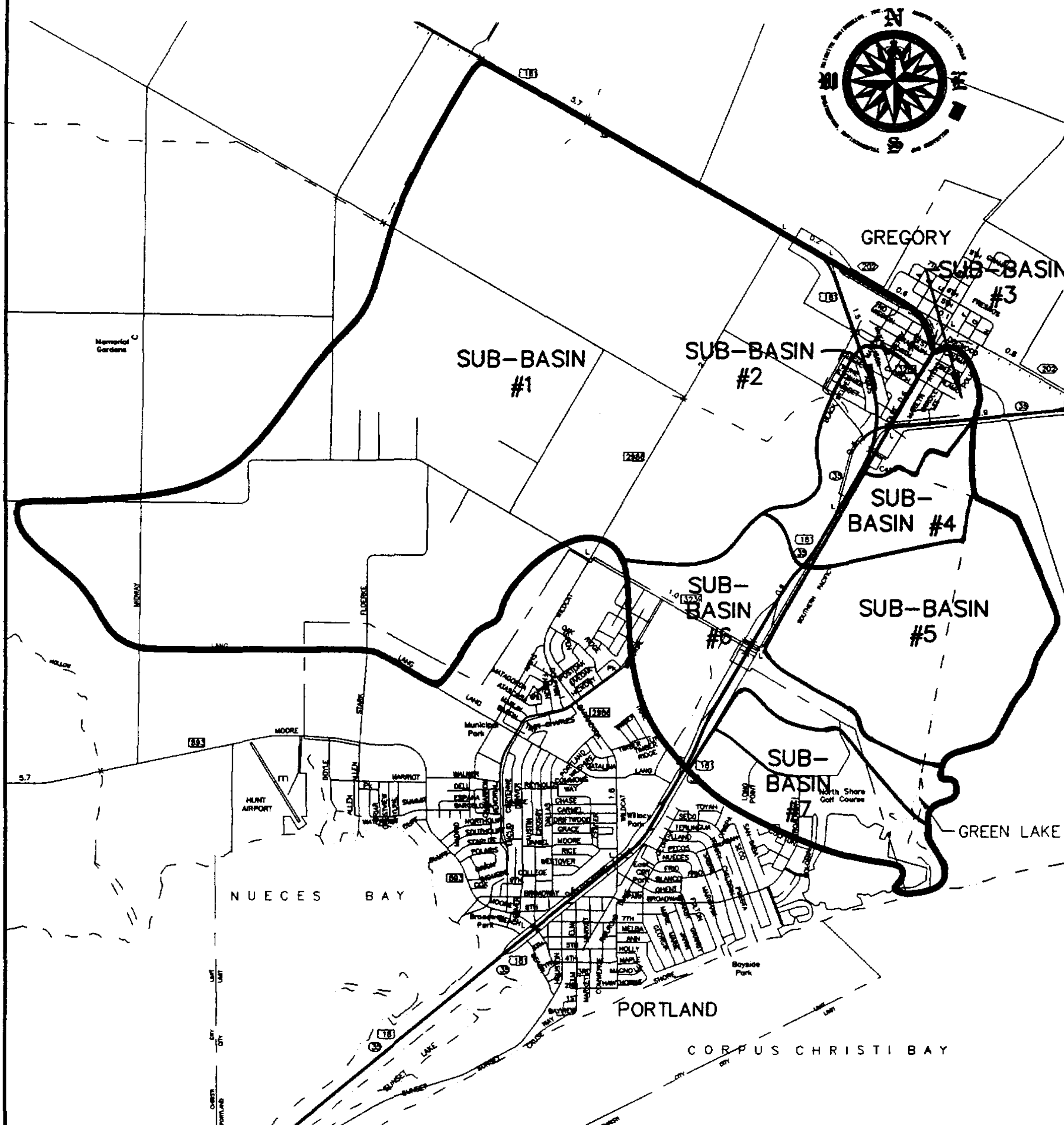
Drawn By: A.NORIEGA	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-EM1
Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:

contour mapping (Figure 3-2).

Currently, the majority of the Green Lake drainage area is cropland. The areas south of the existing residential neighborhoods of southwest Gregory and north of the developed area of Portland, extending from Sunset Road (in Gregory) through the east sides of the main and downstream lake portions of the channel, are areas used for agricultural crops. In the future these agricultural areas may possibly be developed for industrial, commercial, or residential facilities. Above stations 159+40 to 106+70, a mix of both cropland areas and commercial/light industrial businesses are located. In the future, cropland acreage located to the west of the main channel portion may be developed as an extension of the Northshore residential development that exists to the south of the area. The western downstream portion of Green lake Channel is the existing Northshore Country Club Golf Course development.

The area south of Gregory and north of Portland on the west side of U.S. 181 is the primary growth corridor for the area. Most likely future development for all land in this area would include: (1) Residential tracts averaging one-fourth acre each for the area from FM 2986 eastward, and (2) Residential tracts averaging one-half to one acre each from FM 2986 to the west. In addition, a 1,000-foot wide corridor of future commercial/business development is assumed to straddle U.S. 181, FM 3239, and FM 2986 throughout the watershed.

During the past year, construction was started on a TxDOT improvement project at the interchange of U.S. 181 and SH-35. Prior to the construction, U.S. 181 structures consisted of two parallel bridges across the Green Lake Channel for northbound and southbound highway lanes. Each bridge was approximately 40 feet wide and constructed to the elevation ofapproximately 31.3 feet. The existing Green Lake Channel width near the old bridge structures was approximately 40 feet.



GRAPHIC SCALE IN FEET

4000 2000 0 4000 8000

HORIZONTAL

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NORTHSHORE PLANNING STUDY

GREEN LAKE DRAINAGE BASIN MAP

FIGURE 3 - 2

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Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:	of

The interchange project is scheduled for completion in 1994. When completed, the improved conditions will be as follows: the former U.S. 181 northbound main lanes will be converted to a northbound frontage road. The existing bridge structure will remain in place. The old bridge structure on the former U.S. 181 southbound main lanes will be removed. New northbound and southbound main lanes will be constructed as elevated bridge sections north of the Green Lake Channel that transitions to an embankment area to the south edge of the Green Lake Channel. When completed, Green Lake Channel, in this section, will be cleaned out and regraded, but no widening is planned as part of the TxDOT project.

Upstream from the new main lane bridges, a new southbound entrance ramp and southbound frontage roads will be constructed across Green Lake Channel. Three seven-foot by 10-foot box culverts will be constructed at each crossing. Elevations of the top of the culverts are approximately at 32.5 feet and 30.91 feet. No changes to the existing Southern Pacific Railroad (SPRR) bridge are included as part of the TxDOT project.

3.4 Photogrammetric Mapping

Previous studies, such as the 1987 Flood Control Study, were limited to 5-foot contour maps and minor field survey work. Topographic information utilized in the FEMA Study was also limited to USGS 7.5 minute series quadrangle maps with 5-foot contours. An attempt to produce an overall flood boundary map of the Green Lake area from existing FEMA floodway maps found the flood boundaries established by FEMA to be inconsistent. Flood boundary match lines from the City of Gregory floodway map did not correspond with the flood boundary match lines for the unincorporated areas of San Patricio County floodway map.

As a part of this project the SPCDD prepared aerial photogrammetric one-foot contour mapping for approximately 3,000 acres of the Northshore planning area. This includes the flood prone areas of Portland and Gregory associated with the Green Lake outfall system. In addition, the City of Portland and the City of Gregory also participated in the funding of the topographic mapping which included their entire city limits and much of the unincorporated areas of San Patricio County within the Green Lake Watershed. The maps prepared by the SPCDD provided significant information on the overall Green Lake watershed, and were used as the basis for all hydrologic and hydraulic modeling. The one-foot topographic contour maps aided to more accurately define drainage flow patterns and describe cross section geometries for the HEC-2 computer model (Section 3.5). The mapping also assisted in better delineation of flood plain boundaries. In addition, the 1-foot topographic contour mapping will provide valuable information for future drainage and land development projects as well as for other types of work that may require detailed field surveys.

3.5 Computer Modeling of Green Lake

3.5.1 Hydrologic Modeling of the Green Lake Drainage System

As discussed in Section 3.1.2, the Drainage Criteria and Design Manual (Ref. 6) for San Patricio County has guidelines for computing peak flow quantities using regional regression equations developed by the USGS. However, these equations only compute the peak flow and do not provide information regarding the timing of the peak or the total volume of runoff for a given frequency rainfall event. Temporal distribution and total volume of runoff are necessary for evaluation of flood control improvement alternatives at Green Lake. Therefore, a more detailed hydrologic analysis of the Green Lake drainage area was necessary.

The Flood Hydrograph Package HEC-1, developed by the U.S. Army Corps of Engineers, was deemed the best tool for this analysis. The HEC-1 model uses input data describing the basin characteristics (drainage area, soil type and land use) and precipitation frequency depths to compute a storm runoff hydrograph. The drainage areas were delineated (Figure 3-2) using the new 1-foot contour maps generated as part of this study. In addition, information from TxDOT regarding new drainage structures included in the highway improvements currently under construction north of Green Lake was used to better define drainage boundaries in the northeast corner of the basin. Soil types, hydrologic properties of the soils, and some land use information were obtained from the Soil Conservation Service's soil survey of San Patricio County (Ref. 9). Precipitation information for the 5-, 10-, 25-, 50-, and 100-year return period events was obtained using the National Weather Service's TP-40 and Hydro-35 (Refs. 15 and 16).

HEC-1 also has routines that route computed hydrographs through a reservoir and spillway system using a level-pool routing technique. This procedure was used to evaluate the effectiveness of spillway improvement alternatives with regard to reducing the peak water surface elevation in Green Lake for a given flood event.

As shown in Figure 3-2, the Green Lake drainage basin was subdivided into seven sub-basins. The outlet of each of these sub-basins represents a point or node on the Green Lake Channel where peak flows for the hydraulic analysis were needed. The HEC-1 model was constructed so that peak flows at each node were computed for all five precipitation frequency events. In addition, each flood frequency event was routed through the Green Lake spillway using HEC-1, and the maximum computed water surface elevation in the lake was used as the starting water surface elevation for the Green Lake Channel hydraulic modeling.

3.5.2 Hydraulic Modeling of Green Lake Channel

Hydraulic modeling of various improvements to the Green Lake Channel was performed using the HEC-2 Water Surface Profiles Program developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. The program is capable of rapidly computing the water surface profile for a given flow rate in a channel of any cross section subject to either subcritical or supercritical flow conditions. The effects of various hydraulic structures such as bridges, culverts, weirs, levees, and dams may be considered in the computation. A computer program of this type is well suited for the performance of flood studies, as a large volume of data can be evaluated simultaneously, and the impacts of the channel and structural improvements may be readily assessed.

The computational procedure employed by the HEC-2 program applies Bernoulli's theorem for the total energy at each cross section and Manning's formula for the friction head loss between cross sections. The Manning Equation is defined as follows:

$$\mathbf{Q = (1.486/n)A(R_h)^{0.667}(S_f)^{0.5}}$$

where:

Q = Discharge in cfs
n = Roughness coefficient
A = Cross sectional area of flow in sq. ft.
R_h = Hydraulic Radius in ft. = A/P
P = Wetted perimeter in ft.
S_f = Friction slope in ft./ft.

Average friction slope for a reach between two cross sections is determined in terms of the average of the conveyances at the two ends of the reach. Other losses at transitions in channel geometry and bridge structures are computed using one of several methods discussed in the HEC-2 User's Manual.

In order to evaluate possible alternative flood control improvements that could be constructed, it was necessary to first establish a baseline of existing conditions. A HEC-2 model was prepared to accurately reflect existing conditions within the watershed of the Green Lake System.

Cross section data, channel reach length, peak discharge rates, and values of the Manning roughness coefficient are the basic required inputs to the HEC-2 program. The Green Lake HEC-2 model was developed using the one-foot topographic contour mapping prepared by the SPCDD (Section 3.4) to define cross section geometries and channel reach lengths. TxDOT culvert design plans and the 1987 Flood Control Study HEC-2 model were utilized to provide modeling data for the culverts and bridge information for the SPRR and U.S. 181. Peak discharge rates (Q) and starting water elevations (WSEL) for future developed conditions for the 100-year, 50-year, 25-year, 10-year, and 5-year storm events were obtained from HEC-1 analyses. Input n-values were selected on the basis of information from the HEC-2 User's manual and were verified by field reconnaissance. Typical n-values used include:

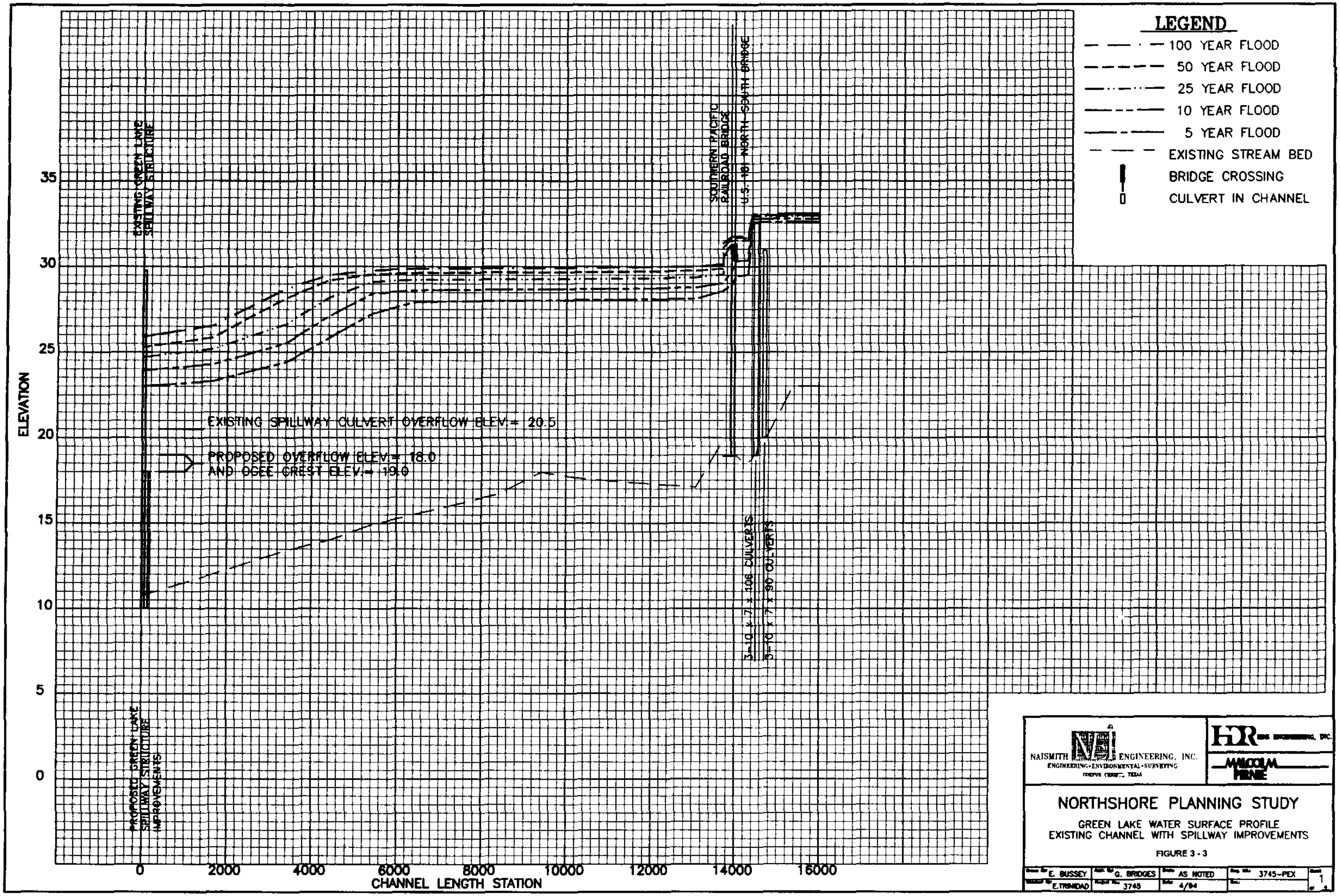
Manning's n Coefficient	
n	Channel Conditions
0.045	Improved Grass Channel
0.06 - 0.045	Natural Channels and Overbank Areas

The sensitivity of water surface elevations to discharge and channel geometry is low in many portions of San Patricio County due to the flat overbank areas. As storm water runoff exceeds the bank-full capacity, flow spills out into the flat overbank areas and establishes new flow patterns. In some instances the direction of the overland flow is normal to the channel flow and would require a substantially more detailed model to accurately depict the flow patterns which develop. However, a detailed model that would include these conditions is not warranted for analysis purposes. The capacity of overbank floodplain areas to store water is so great that a large increase in runoff may result in only a small increase in flood elevations. When simulating these conditions in HEC-2, the effective flow area of a floodplain is determined and cross sections are vertically extended at that point. When extensions at a particular section exceed one foot, the cross section and/or hydrology may require modification. However, sections and overbank slopes are sometimes modified to provide for uniform flow regimes along a particular channel reach.

3.5.3 Alternatives Evaluated

As previously mentioned, a Green Lake System HEC-2 model for existing conditions (base model) with spillway improvements was developed to establish a baseline (Figure 3-3). For analyses purposes, the assumption was made that all discharge from the watershed would outfall to the Green Lake Drainage System, although in reality the La Quinta Ditch would provide some relief of the overbanking flow. It was also assumed that railroad and highway structures would be hydraulically improved to provide adequate conveyance capacity for storm water flows (Figure 3-4).

Review of the base model showed inundation of the area surrounding the Green Lake System for the 100-year, 50-year, 25-year, 10-year, and 5-year storm events analyzed. The base model suggested the Green Lake area and the surrounding areas are generally subjected to two primary sources of flooding. One source is due to the inadequate capacity of the Green Lake Channel produced by the restrictions within the upstream and main portions of the channel. During larger storm events, the conveyance capacity of the channel is also restricted by existing



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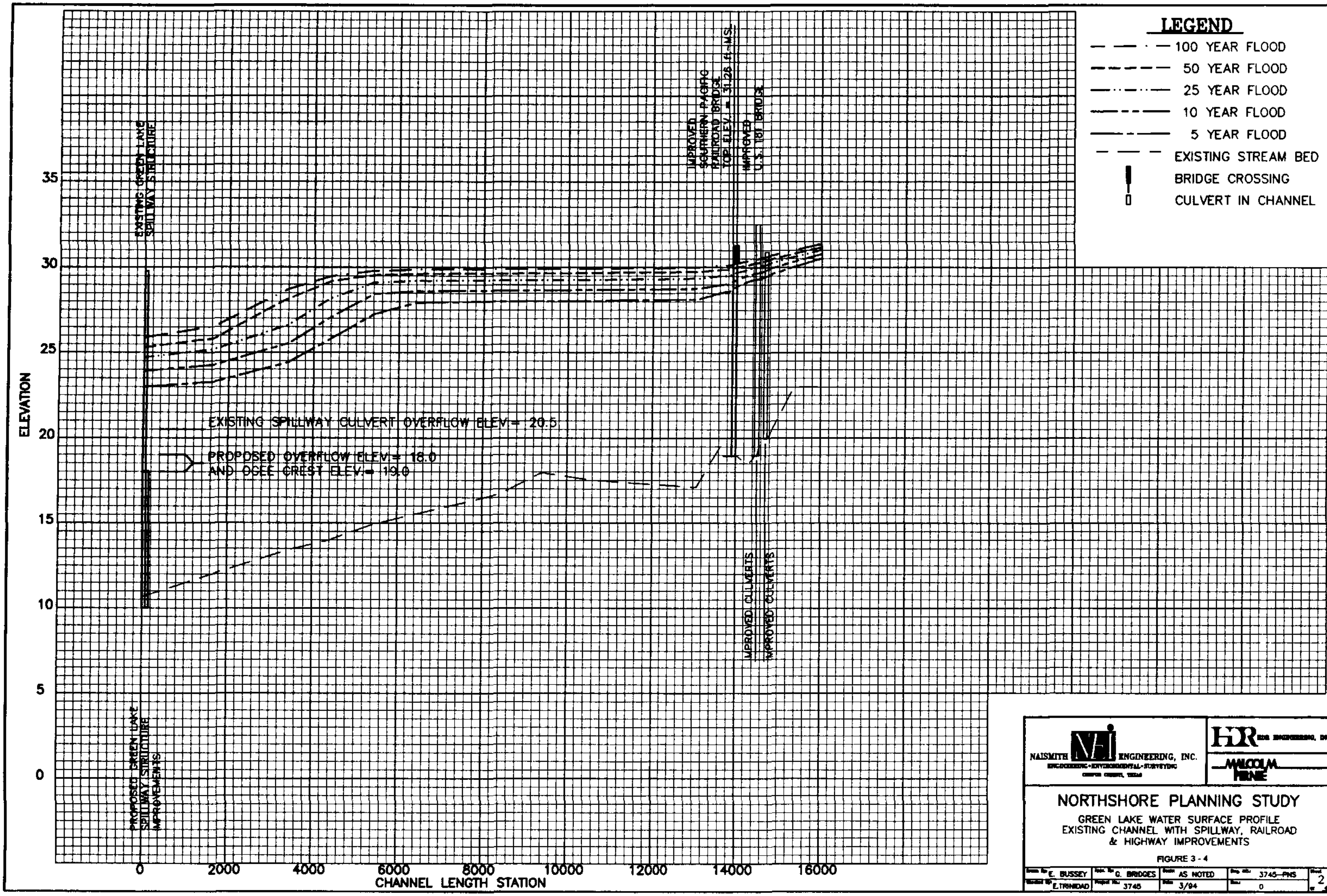
GREEN LAKE WATER SURFACE PROFILE
EXISTING CHANNEL WITH SPILLWAY IMPROVEMENTS

FIGURE 3 - 3

E. BUSSEY	G. BRIDGES	AS NOTED	3745-PEX	1
E.TRINIDAD	3745	4/94		


LEGEND
100 YEAR FLOOD
50 YEAR FLOOD
25 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
EXISTING STREAM BED
BRIDGE CROSSING
CULVERT IN CHANNEL
EXISTING GREEN LAKE SPILLWAY STRUCTURE
IMPROVED SOUTHERN PACIFIC RAILROAD BRIDGE TOP ELEV. = 31.26 ft-MSL
IMPROVED U.S. 181 BRIDGE
EXISTING SPILLWAY CULVERT OVERFLOW ELEV = 20.5
PROPOSED OVERFLOW ELEV = 18.0
AND OGEE CREST ELEV = 19.0
IMPROVED CULVERTS
IMPROVED CULVERTS
PROPOSED GREEN LAKE SPILLWAY STRUCTURE IMPROVEMENTS
ELEVATION
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
12000
14000
16000
CHANNEL LENGTH STATION
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NORTHSHORE PLANNING STUDY
GREEN LAKE WATER SURFACE PROFILE
EXISTING CHANNEL WITH SPILLWAY, RAILROAD
& HIGHWAY IMPROVEMENTS
FIGURE 3 - 4
E. BUSSEY
G. BRIDGES
AS NOTED
3745-PNS
E.TRINIDAD
3745
3/94
0
2

railroad and highway structures, and the Green Lake spillway. The second major source of flooding is from poor drainage due to the relatively flat topography of the area. Lack of topographic relief and the low permeability rates of the soils in the vicinity tend to cause storm water runoff to pond or move across a large area of land in a sheet flow pattern rather than in defined drainageways.

The recently obtained 1-foot topographic contour maps, the 1987 Flood Control Study, and the HEC-2 base model were all used to establish the design target water surface elevation of 28.0 feet-msl for the 100-year flood frequency in the southwestern portion of Gregory (station 159+40). HEC-2 models were then developed to include the following channel improvements: (1) widening the bottom of the channel, (2) excavation of the channel, (3) lowering the starting water surface elevation, and (4) a combination of the alternatives.

A HEC-2 model was developed to analyze the effect of lowering the starting water surface elevation (WSEL). A target WSEL for the 100-year flood was set at 24.0 feet at the dam. The model demonstrated that a lower WSEL would lower the water elevation in the main portion of the channel, thus reducing inundation of the surrounding area. However, due to the restrictions of the upstream portion of the channel, a lower WSEL at the dam did not result in a substantial lowering of the water surface elevation in Gregory. The proposed spillway has a weir length of 75 feet and produces a WSEL of 25.9 feet for the 100-year flood frequency. Lowering the WSEL would involve designing an alternative spillway with a longer weir. The benefits of lowering the WSEL are limited when compared to the expense of constructing a longer spillway. Numerous HEC-2 analyses were performed, including various combinations of potential improvements. The most effective channel improvements that help to alleviate flooding throughout the Green Lake area are channel widening and channel excavation. Combinations of increasing the bottom width (BW) of the upstream, downstream, and main portions of the channel were all evaluated. Widening the BW of the downstream portion of the channel did not significantly lower the water surface elevation in Gregory (Station 159+40). Even though the combination of widening the BW and excavating the upstream and main portions of the channel proved to be the most effective flood control measures, the target water surface elevation of 28.0 feet-msl with complete containment of the 100-year flood within the channel banks could not be achieved (Section 3.6.1).

In addition, a preliminary analysis for diverting flow into La Quinta Ditch was performed. It was found that approximately 4,000 cfs of flow would have to be diverted into La Quinta ditch in order to fully contain the 100-year flow in the improved Green Lake Channel described above. Also, the HEC-1 model was used to investigate removing a portion of the drainage area for the Green Lake Basin, similar to that which was evaluated in the 1987 Flood Control Study (Section 4.7).

3.6 Evaluation of Alternative Flood Management Plans

3.6.1 Green Lake Spillway Improvements

The dam and spillway structure which forms Green Lake was originally constructed [in 1940] as an erosion control measure. The structure consists of an earthen embankment with ten, 48-inch diameter concrete conduits which serve as the spillway. The upstream portions of the conduits are vertical risers which penetrate a 14-foot by 75-foot horizontal concrete sill; each of the ten conduits are laid out along a common axis parallel to the dam centerline. The sill acts as the spillway crest and controls the pool level in Green Lake. The conduits undergo a 90-degree bend and discharge through a concrete headwall into a channel at a point approximately 500 feet upstream of the mouth at Corpus Christi Bay.

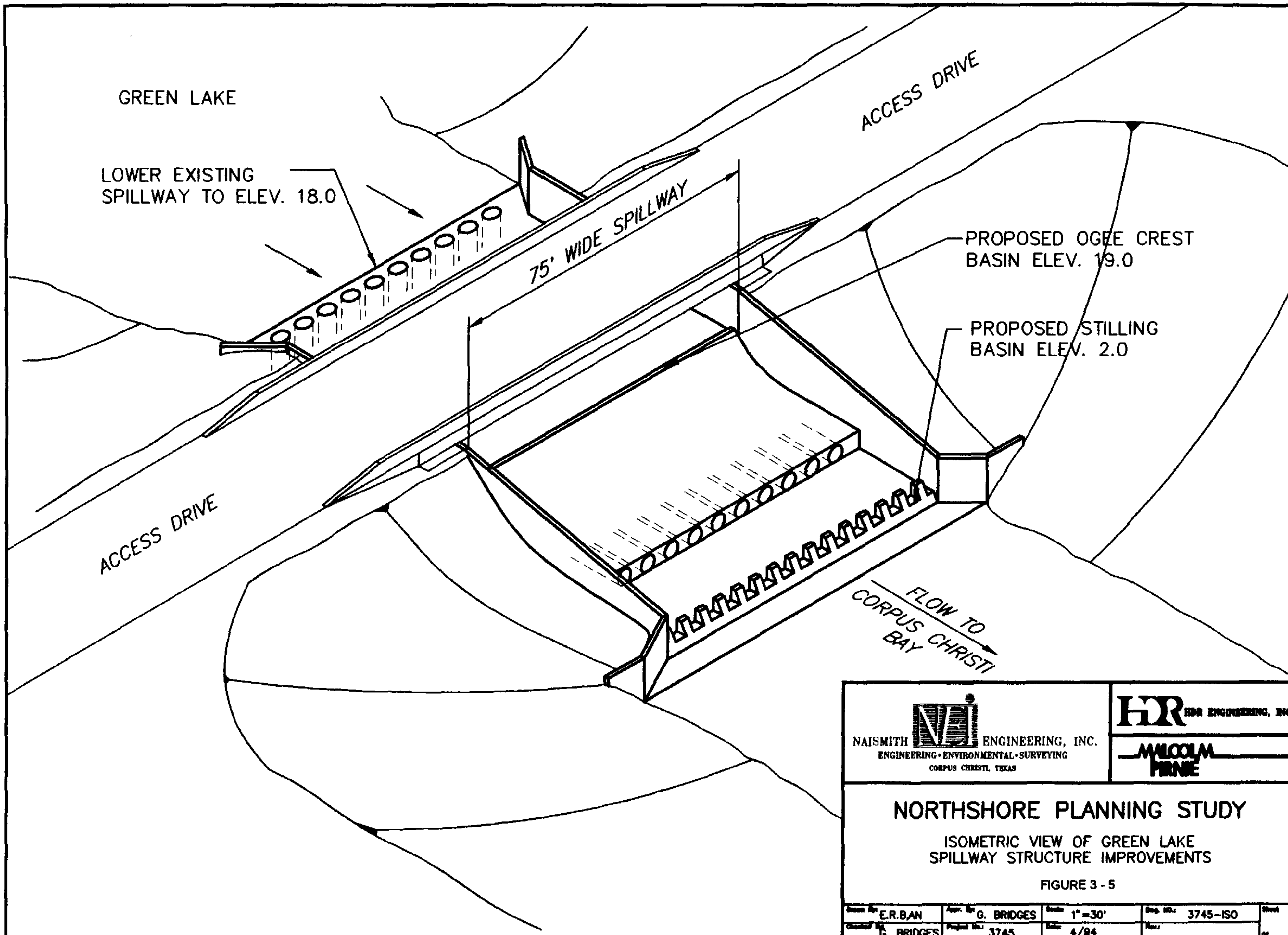
In 1986, modifications were made to the spillway structure in order to reduce the normal pool level in Green Lake and correct leakage problems in the riser portions of the conduits. The concrete conduits were slip-lined with 36-inch diameter corrugated steel pipes and the concrete sill was lowered approximately two feet to elevation 20.6 feet msl.

Further modifications to the Green Lake Dam and Spillway Structure are proposed in order to provide flood relief in the upper reaches of Green Lake as well as the City of Gregory. The proposed modifications call for the concrete sill (and top of risers) to be dropped to elevation 18.0 feet msl and for much of the current embankment to be removed and replaced with a "run-of-river" concrete ogee spillway with a crest elevation of 19.0 feet msl. The ogee spillway would have a crest length of 75 feet and would require the construction of new concrete retaining walls and an access bridge (Figure 3-5).

The proposed modifications to the Green Lake Dam and Spillway Structure will lower the 100-year pool in Green Lake from elevation 30.0 to 25.9 feet msl.

3.6.2 Green Lake Channel Improvements

Improvements proposed in the 1987 Flood Control Study and an assumed maximum drainage easement width of 300 feet were used as guidelines to develop the proposed ultimate channel improvements. Ultimate channel improvements for the main and upstream portion of the Green Lake Channel, stations 35+00 to 159+40 include excavating a pilot channel at a slope of 0.035 percent with a bottom width of 125 feet and 3:1 side slope (Figure 3-6). Also included in the proposed ultimate channel improvements for the main channel, stations 35+00 to 106+70, is lowering and widening the existing overbank areas to elevation 18 feet, with a



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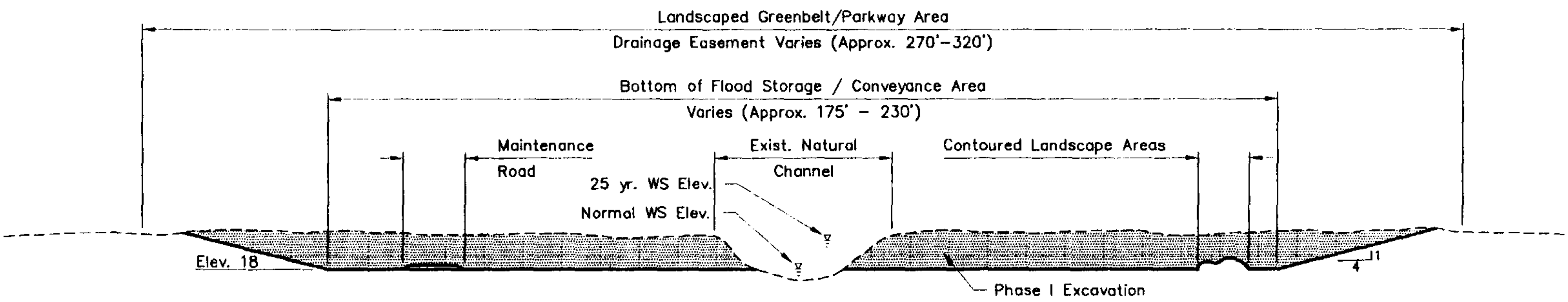
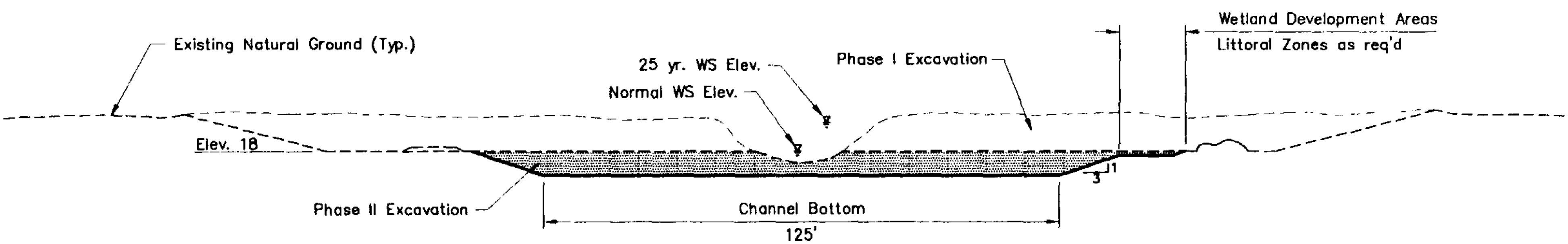
ISOMETRIC VIEW OF GREEN LAKE SPILLWAY STRUCTURE IMPROVEMENTS

FIGURE 3 - 5

Drawn By E.R.BAN	Appr. By G. BRIDGES	Scale 1"=30'	Dwg. No. 3745-ISO
Checked By C. BRIDGES	Project No. 3745	Date 4/94	Rev.



PHASE I



PHASE II

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NORTHSHORE PLANNING STUDY

TYPICAL CHANNEL CROSS SECTION IMPROVEMENTS – STA. 35+00–106+70

FIGURE 3 - 6

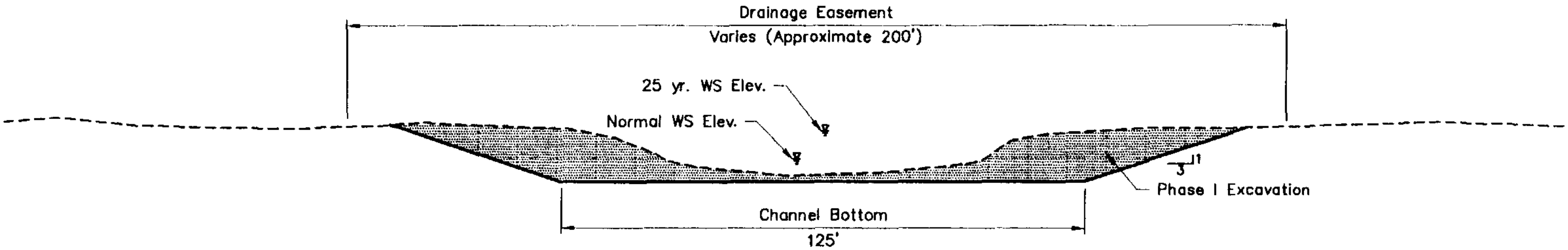
E. BUSSEY	G. BRIDGES	NONE	3745-X1
E. TRINIDAD	3745	4/94	

meandering bottom width ranging from 175 feet to 250 feet with 4:1 side slopes (Figure 3-7). Bottom widths for the channel improvements were based on an assumed allowable channel top width of 300 feet.

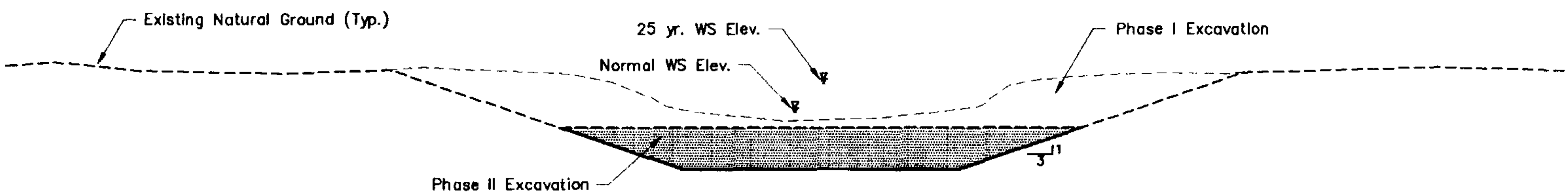
In order to minimize overall construction costs, planning for ultimate channel improvements was based on the concept that the SPCDD, with its available maintenance equipment and personnel, would implement the project in phases. It is anticipated that excavated material will be spread on adjacent property, or stockpiled, at the owner's option.

The ultimate channel section also lends itself to development of the linear overbank area above elevation 18.0 feet into a "greenbelt" or "parkway". Greenbelts can provide beneficial water resource, ecological, and recreational values. One of the more obvious water resource values of a greenbelt is the provision for natural flood storage and conveyance. In addition, a greenbelt can aid to reduce flood peaks by slowing surface water runoff. Greenbelts can also provide a useful function in water quality maintenance by filtering sediments, debris, and by controlling non-point source pollution caused by runoff. Ecological benefits include the large and diverse populations of plants and animals the greenbelt will support. Aesthetically the greenbelt can enhance the natural landscape and emphasize recreation experiences based upon the appreciation of the natural surroundings. An "open space" parkway including hiking/biking trails and picnic areas could be incorporated into the development. Such a parkway amenity may be qualified for State grant funding through a Parks and Recreation Grant, or State Revolving Fund financing as a Non-Point Source Pollution Prevention Project.

The creation of littoral zones along the channel may be incorporated into the design to provide mitigation for impacts, if required. These shallow water areas will provide wetland and floodplain vegetation buffers that reduce sedimentation, reduce peaks by slowing surface water runoff and provide aquatic habitats.



PHASE I



PHASE II

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NORTHSHORE PLANNING STUDY

TYPICAL CHANNEL CROSS SECTION
IMPROVEMENTS – STA. 106+70–159+40

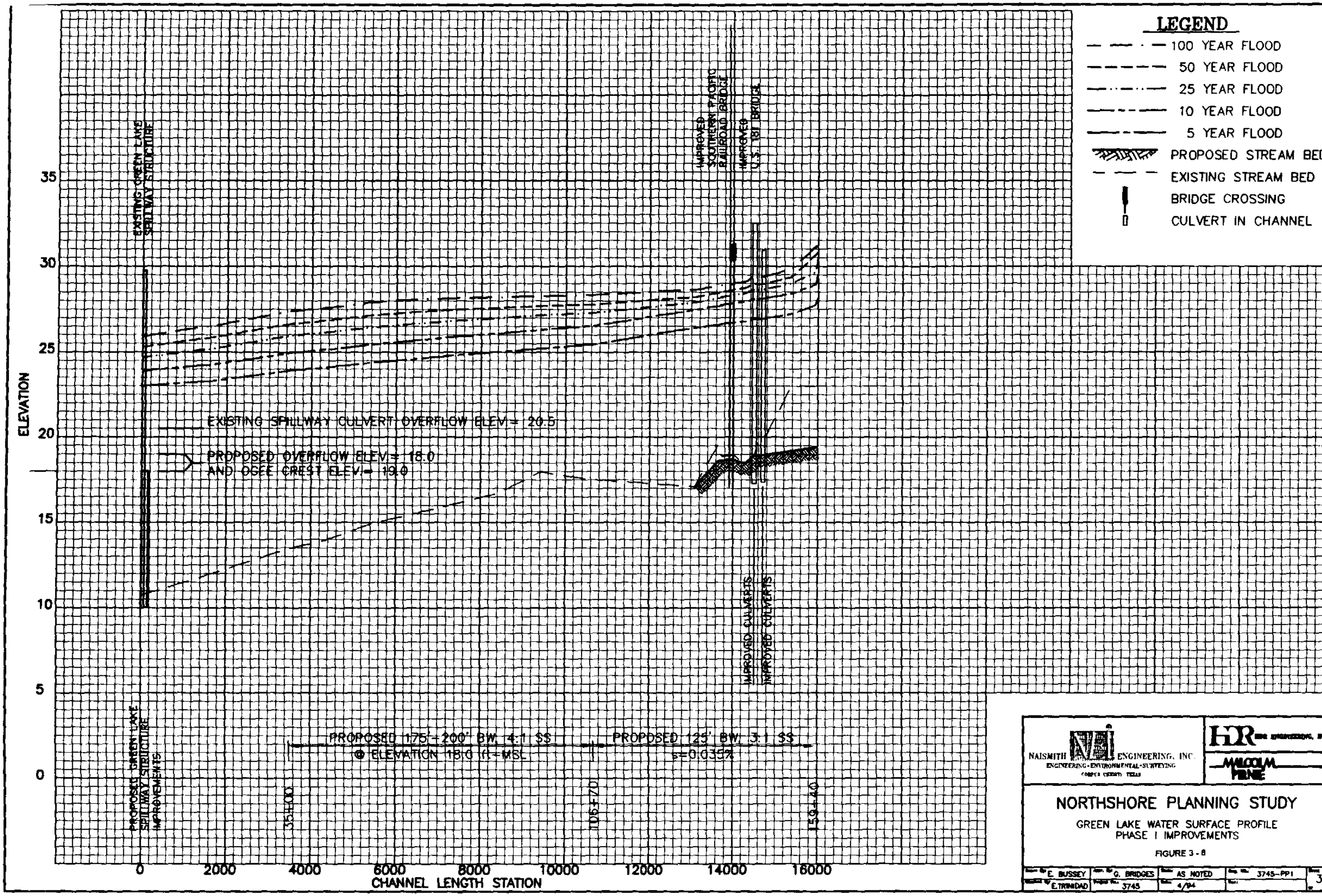
FIGURE 3 - 7

E. BUSSEY	G. BRIDGES	NONE	3745–X2	
E. TRINIDAD	3745	4/94		

3.6.2.1 Phase I Improvements

Phase I improvements assume that railroad and highway structures will be hydraulically improved to provide adequate conveyance capacity for storm water flows. The proposed Phase I improvements include excavation to lower and widen the existing overbank areas to elevation 18 feet. A meandering bottom width to elevation 18 feet that varies between approximately 175 feet to approximately 250 feet is proposed for the main portion of the channel, Stations 35+00 to 106+70. Maximum 4:1 side slopes are proposed in order to enhance the greenbelt area and provide for ease of maintenance (Figure 3-4). Proposed Phase I improvements for the upstream portion of the Green Lake Channel, Station 106+70 to Station 159+40, include excavation at a slope of 0.035 percent with a bottom width of 125 feet and 3:1 side slopes. A stabilized roadbed that parallels the channel is also recommended in Phase I to allow ease of access for routine maintenance and future Phase II improvements. The access road can be incorporated into the greenbelt design in order to provide maintenance of drainage and park facilities. It is anticipated that the majority of Phase I construction will be performed by SPCDD. Typical cross sections are shown in Figures 3-6 and 3-7.

Phase I improvements provide significant flooding relief to the flood prone Green Lake area. Figures 3-3, 3-4, and 3-8 show computed water surface profiles for existing conditions and Phase I conditions, respectively. A comparison of the profiles shows that the existing 100-year water surface elevation in Gregory (Station 159+40) is lowered by 1.9 feet, from approximately elevation 33.1 to approximately elevation 31.2, by implementation of Phase I improvements. Phase I will also improve the conveyance capacity of Green Lake Channel, allowing the channel to contain the 5-year flood in its entirety (Table 3-1). A review of the calculations shows that throughout the Green Lake Channel, Phase I improvements will significantly lower the Calculated Water Surface Elevations (CWSEL), thus reducing flooding


LEGEND
100 YEAR FLOOD
50 YEAR FLOOD
25 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
PROPOSED STREAM BED
EXISTING STREAM BED
BRIDGE CROSSING
CULVERT IN CHANNEL
ELEVATION
35
30
25
20
15
10
5
0
EXISTING GREEN LAKE SPILLWAY STRUCTURE
IMPROVED SOUTHERN PACIFIC RAILROAD BRIDGE
IMPROVED U.S. 181 BRIDGE
EXISTING SPILLWAY CULVERT OVERFLOW ELEV.= 20.5
PROPOSED OVERFLOW ELEV.= 18.0
AND OGEE CREST ELEV.= 19.0
IMPROVED CULVERTS
IMPROVED CULVERTS
PROPOSED 175'-200' BW, 4:1 SS
@ ELEVATION 18.0 ft-MSL
PROPOSED 125' BW, 3:1 SS
s=0.035%
PROPOSED GREEN LAKE SPILLWAY STRUCTURE IMPROVEMENTS
35+00
106+70
159+40
0
2000
4000
6000
8000
10000
12000
14000
16000
CHANNEL LENGTH STATION
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MALCOLM PIRNIE
NORTHSHORE PLANNING STUDY
GREEN LAKE WATER SURFACE PROFILE
PHASE I IMPROVEMENTS
FIGURE 3-8
E. BUSSEY
E.TRINIDAD
G. BRIDGES
3745
AS NOTED
4/94
3745-PP1
3

in surrounding lands and in the southwestern portion of Gregory (Table 3-1). The calculation also show that inundation of the flood prone Green Lake area will be significantly reduced, especially for the lower frequency storms (Table 3-1).

As previously mentioned, incorporation of a greenbelt concept into Phase I improvements may allow application to be made for a Texas Parks and Wildlife Recreation Grant, to assist with project funding.

3.6.2.2 Phase II Improvements

Proposed Phase II improvements include excavating the main and upstream portions of the Green Lake Channel, from Station 35+00 to 159+40, at a slope of 0.035 percent with a bottom width of 125 feet and 3:1 side slopes. Further development of the greenbelt area may be implemented during Phase II, as funds are available.

Phase II improvements will lower the CWSEL in southwestern Gregory, station 159+40, by approximately 1.9 feet, from the Phase I CWSEL at approximately 31.2 feet to the Phase II CWSEL of approximately 29.3 feet (Figure 3-9). In comparison to existing conditions, Phase II will reduce the CWSEL a total of 3.8 feet, from the estimated existing conditions CWSEL of 33.1 feet to the Phase II conditions CWSEL of approximately 29.3 feet A comparison of the computed water surface profiles for each of the conditions shows that Phase II improvements substantially reduce the existing conditions CWSEL for all the flood frequencies analyzed (Figures 3-8 and 3-9). A summary of the HEC-2 CWSEL and top widths (the width floodwaters will inundate the surrounding area) for the existing conditions, hydraulically improved structure conditions, Phase I conditions, and Phase II conditions is shown in Table 3-1. A comparison of the top widths shows that Phase II improvements will significantly reduce inundation of the surrounding lands throughout the Green Lake Channel area, including in Gregory (Table 3-1).

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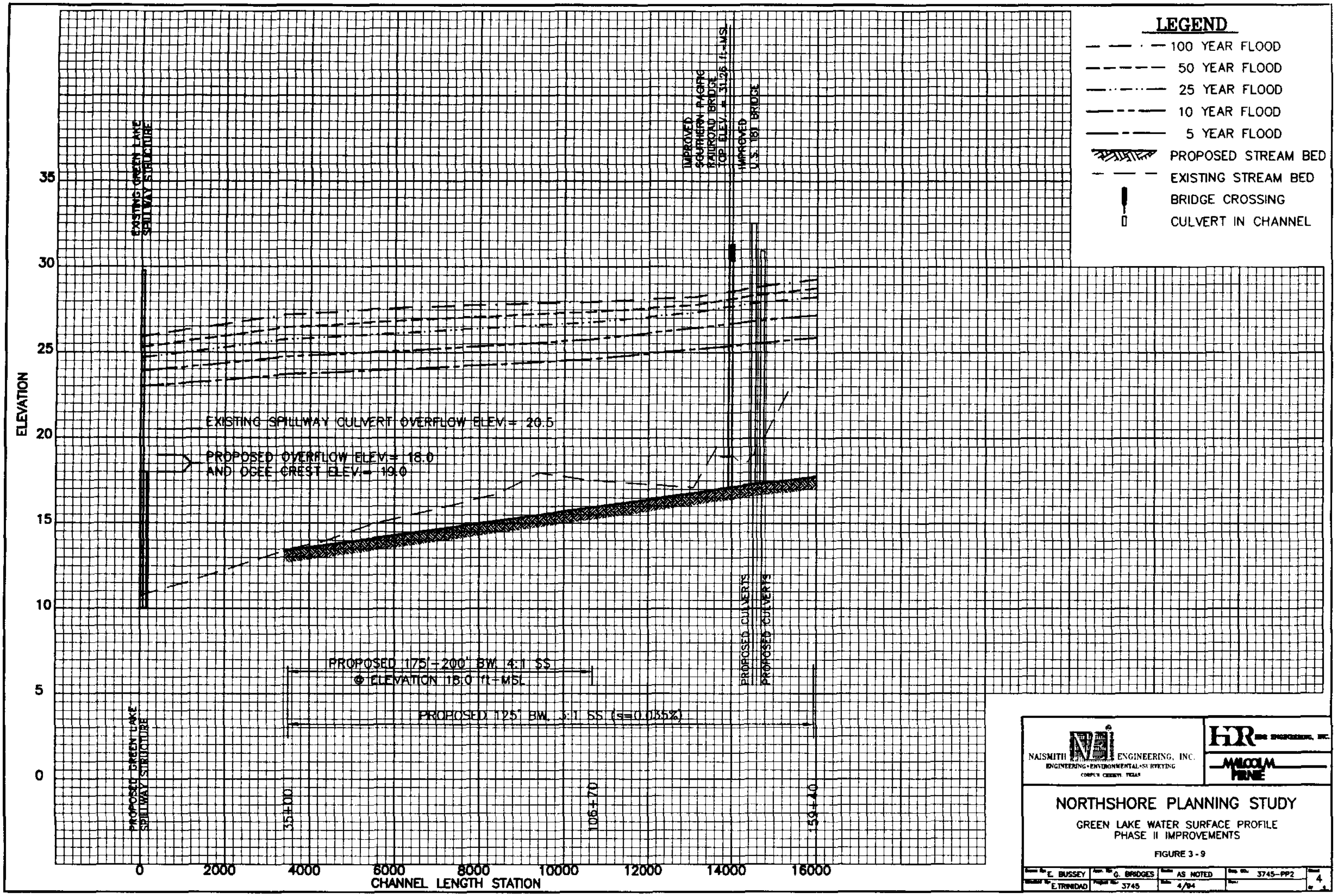
LEGEND
100 YEAR FLOOD
50 YEAR FLOOD
25 YEAR FLOOD
10 YEAR FLOOD
5 YEAR FLOOD
PROPOSED STREAM BED
EXISTING STREAM BED
BRIDGE CROSSING
CULVERT IN CHANNEL
EXISTING GREEN LAKE SPILLWAY STRUCTURE
IMPROVED SOUTHERN PACIFIC RAILROAD BRIDGE TOP ELEV. = 31.25 ft-MSL
IMPROVED U.S. 181 BRIDGE
EXISTING SPILLWAY CULVERT OVERFLOW ELEV = 20.5
PROPOSED OVERFLOW ELEV = 18.0
AND OGEE CREST ELEV = 19.0
PROPOSED 175'-200' BW 4:1 SS
@ ELEVATION 18.0 ft-MSL
PROPOSED 125' BW, 3:1 SS (s=0.035%)
PROPOSED CULVERTS
PROPOSED CULVERTS
PROPOSED GREEN LAKE SPILLWAY STRUCTURE
35+00
106+70
159+40
ELEVATION
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
12000
14000
16000
CHANNEL LENGTH STATION
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GREEN LAKE WATER SURFACE PROFILE
PHASE II IMPROVEMENTS
FIGURE 3-9
E. BUSSEY
G. BRIDGES
AS NOTED
3745-PP2
E.TRINIDAD
3745
4/94
4

TABLE 3-1

GREEN LAKE CHANNEL IMPROVEMENTS
CALCULATED WATER SURFACE ELEVATIONS*

Tr (Year)	Cross Section Station	Q(cfs)	Existing Channel with Spillway Improvments		Existing Channel with Spillway, Railroad and Highway Improvments		Phase 1 Improvements		Phase 2 Improvements	
			CWSEL	TW	CWSEL	TW	CWSEL	TW	CWSEL	TW
	1+00									
5		2800	23.00	175	23.00	175	23.00	175	23.00	175
10		3600	23.90	180	23.90	180	23.90	180	23.90	180
25		4500	24.70	195	24.70	195	24.70	195	24.70	195
50		5100	25.30	200	25.30	200	25.30	200	25.30	200
100		**5900**	**25.90**	**210**	**25.90**	**210**	**25.90**	**210**	**25.90**	**210**
5	13+85	2800	23.23	150	23.23	150	23.23	150	23.23	150
10		3600	24.19	160	24.19	160	24.19	160	24.19	160
25		4500	25.09	190	25.09	190	25.09	190	25.09	190
50		5100	25.74	200	25.74	200	25.74	200	25.74	200
100		**5900**	**26.41**	**220**	**26.41**	**220**	**26.41**	**220**	**26.41**	**220**
5	17+60	2800	23.29	125	23.29	125	23.29	125	23.29	125
10		3600	24.27	130	24.27	130	24.27	130	24.27	130
25		4500	25.19	135	25.19	135	25.19	135	25.19	135
50		5100	25.84	135	25.84	135	25.84	135	25.84	135
100		**5900**	**26.52**	**140**	**26.52**	**140**	**26.52**	**140**	**26.52**	**140**
5	35+00	2600	24.40	85	24.40	85	23.87	295	23.70	295
10		3400	25.54	90	25.54	90	24.92	305	24.75	305
25		4200	26.62	95	26.62	95	25.92	315	25.75	310
50		4900	28.18	925	28.18	925	26.61	320	26.45	320
100		**5600**	**28.74**	**1535**	**28.74**	**1535**	**27.35**	**325**	**27.19**	**325**
5	45+00	2600	25.81	90	25.81	90	24.11	225	23.80	220
10		3400	27.08	100	27.08	100	25.16	230	24.86	230
25		4200	28.19	2660	28.19	2660	26.15	240	25.87	240
50		4900	29.20	3905	29.20	3905	26.85	245	26.58	245
100		**5600**	**29.49**	**4125**	**29.49**	**4125**	**27.59**	**250**	**27.33**	**250**

TABLE 3-1 Continued

GREEN LAKE CHANNEL IMPROVEMENTS
CALCULATED WATER SURFACE ELEVATIONS*

Tr (Year)	Cross Section Station	Q(cfs)	Existing Channel with Spillway Improvments		Existing Channel with Spillway, Railroad and Highway Improvments		Phase 1 Improvements		Phase 2 Improvements	
			CWSEL	TW	CWSEL	TW	CWSEL	TW	CWSEL	TW
5	55+00	2600	27.24	825	27.24	825	24.38	300	23.92	300
10		3400	28.44	2130	28.44	2130	25.44	310	25.01	305
25		4200	29.12	3205	29.12	3205	26.44	315	26.03	315
50		4900	29.54	4065	29.54	4065	27.15	325	26.75	320
100		**5600**	**29.78**	**4535**	**29.78**	**4535**	**27.90**	**1615**	**27.52**	**325**
5	65+00	2600	27.93	3485	27.93	3485	24.59	230	24.03	225
10		2400	28.62	4160	28.62	4160	25.66	235	25.13	233
25		4200	29.22	4710	29.22	4710	26.65	2485	26.16	2040
50		4900	29.62	5015	29.62	5015	27.35	3150	26.89	2775
100		**5600**	**29.86**	**5195**	**29.86**	**5195**	**28.07**	**3625**	**27.65**	**3325**
5	75+00	2600	27.98	5600	27.98	5600	24.83	305	24.17	300
10		3400	28.65	5775	28.65	5775	25.90	1090	25.29	465
25		4200	29.25	5920	29.25	5920	26.84	3235	26.32	2100
50		4900	29.65	6015	29.65	6015	27.48	5240	27.02	4150
100		**5600**	**29.89**	**6075**	**29.89**	**6075**	**28.15**	**5655**	**27.74**	**5440**
5	85+00	2600	28.02	6400	28.02	6400	25.01	230	24.29	225
10		3400	28.67	6400	28.67	6400	26.08	240	25.41	235
25		4200	29.26	6400	29.26	6400	26.98	5520	26.44	245
50		4900	29.66	6400	29.66	6400	27.58	6085	27.12	5740
100		**5600**	**29.90**	**6400**	**29.90**	**6400**	**28.21**	**6400**	**27.81**	**6260**
5	95+00	2600	28.04	5845	28.04	5845	25.21	310	24.43	300
10		3400	28.68	6220	28.68	6220	26.30	3645	25.58	310
25		4200	29.27	6400	29.27	6400	27.17	4760	26.61	4000
50		4900	29.67	6400	29.67	6400	27.70	5560	27.27	4910
100		**5600**	**29.91**	**6400**	**29.91**	**6400**	**28.28**	**5980**	**27.90**	**5720**
5	106+70	2400	28.06	5310	28.06	5310	25.44	215	24.60	200
10		3100	28.70	5375	28.70	5375	26.51	3820	25.76	460
25		3900	29.29	5430	29.29	5430	27.29	4730	26.75	3965
50		4500	29.68	5470	29.68	5470	27.78	5225	27.37	4910

TABLE 3-1 Continued

GREEN LAKE CHANNEL IMPROVEMENTS
CALCULATED WATER SURFACE ELEVATIONS*

Tr (Year)	Cross Section Station	Q(cfs)	Existing Channel with Spillway Improvments		Existing Channel with Spillway, Railroad and Highway Improvments		Phase 1 Improvements		**Phase 2 Improvements**	
			CWSEL	TW	CWSEL	TW	CWSEL	TW	CWSEL	TW
100		**5100**	**29.92**	**5495**	**29.92**	**5495**	**28.34**	**5335**	**27.96**	**5290**
5	131+80	2300	28.13	1690	28.13	1690	26.41	175	25.19	175
10		3000	28.77	2100	28.77	2100	27.46	1145	26.42	185
25		3800	29.35	2340	29.35	2340	27.89	1515	27.34	985
50		4300	29.74	2435	29.74	2435	28.21	1745	27.79	1420
100		**5000**	**29.99**	**2495**	**29.99**	**2495**	**28.63**	**2010**	**28.25**	**1770**
5	137+50	2300	28.54	3040	28.54	3040	26.60	280	25.32	175
10		3000	29.01	3420	29.01	3420	27.71	975	26.59	280
25		3800	29.51	3710	29.51	3710	28.17	2445	27.59	460
50		4300	29.86	3920	29.86	3920	28.47	2965	28.02	2395
100		**5000**	**30.11**	**4000**	**30.11**	**4000**	**28.86**	**3330**	**28.48**	**2970**
5	138+10	2300	28.56	530	28.57	2950	26.63	270	25.34	175
10		3000	29.01	530	29.02	3470	27.74	680	26.62	265
25		3700	29.50	530	29.52	3920	28.20	2520	27.62	610
50		4200	29.85	530	29.87	4240	28.50	2875	28.06	2340
100		**4900**	**30.09**	**530**	**30.12**	**4465**	**28.89**	**3315**	**28.50**	**2860**
5	138+20	2300	28.56	530	28.57	2945	26.63	270	25.34	175
10		3000	29.02	530	29.03	3470	27.75	680	26.62	265
25		3700	30.44	530	29.52	3920	28.21	2515	27.63	615
50		4200	31.07	530	29.87	4240	28.51	2875	28.06	2350
100		**4900**	**31.37**	**5500**	**30.12**	**4460**	**28.89**	**3315**	**28.51**	**2875**
5	138+30	2300	28.61	3170	28.58	3135	26.62	140	25.34	175
10		3000	29.08	3605	29.04	3560	27.72	225	26.62	185
25		3700	30.49	5000	29.53	4270	28.18	2730	27.63	535
50		4200	31.12	5000	29.88	4810	28.48	3030	28.05	2620
100		**4900**	**31.37**	**5000**	**30.12**	**5000**	**28.88**	**3415**	**28.50**	**3055**
5	139+00	2300	28.61	315	28.58	670	26.66	175	25.36	175
10		3000	29.05	330	29.01	775	27.79	310	26.64	185
25		3700	30.49	3005	29.50	2315	28.26	650	27.66	310

TABLE 3-1 Continued

GREEN LAKE CHANNEL IMPROVEMENTS
CALCULATED WATER SURFACE ELEVATIONS*

Tr (Year)	Cross Section Station	Q(cfs)	Existing Channel with Spillway Improvments		Existing Channel with Spillway, Railroad and Highway Improvments		Phase 1 Improvements		Phase 2 Improvements	
			CWSEL	TW	CWSEL	TW	CWSEL	TW	CWSEL	TW
50		4200	31.12	3770	29.86	2380	28.54	670	28.09	635
100		**4900**	**31.37**	**4000**	**30.11**	**2540**	**28.90**	**690**	**28.52**	**665**
5	140+30	2300	28.97	110	28.80	1800	26.70	175	25.39	175
10		3000	29.79	110	29.22	2265	27.83	310	26.67	180
25		3700	31.49	4700	29.65	2340	28.31	1085	27.70	310
50		4200	31.63	4700	29.97	2400	28.59	1495	28.13	815
100		**4900**	**31.73**	**4700**	**30.21**	**2760**	**28.96**	**2035**	**28.56**	**1470**
5	141+10	2300	29.40	2215	28.92	1895	26.72	175	25.41	175
10		3000	30.30	2610	29.32	2165	27.86	635	26.69	180
25		3700	31.49	2905	29.72	2405	28.34	1200	27.71	285
50		4200	31.64	3060	30.02	2570	28.63	1545	28.15	945
100		**4900**	**31.73**	**3115**	**30.25**	**2605**	**29.00**	**1975**	**28.59**	**1510**
5	143+50	2300	29.51	1805	29.17	1315	26.78	140	25.46	175
10		3000	30.35	2980	29.52	1835	27.93	200	26.75	180
25		3700	31.51	4030	29.87	2335	28.42	225	27.78	230
50		4200	31.65	4080	30.14	2700	28.71	325	28.23	255
100		**2900**	**31.75**	**4115**	**30.37**	**3010**	**29.08**	**385**	**28.68**	**280**
5	144+02	2300	29.53	1885	29.21	1410	26.80	140	25.47	175
10		3000	30.36	2840	29.56	1935	27.96	200	26.76	180
25		3700	31.51	3625	29.91	2455	28.46	225	27.80	230
50		4200	31.66	3725	30.18	2715	28.76	330	28.25	255
100		**4900**	**31.76**	**3795**	**30.40**	**2870**	**29.13**	**400**	**28.70**	**280**
5	145+08	2300	32.56	3535	29.30	1115	26.86	265	25.50	175
10		3000	32.74	3550	29.65	1645	28.05	665	26.79	250
25		3700	32.89	3565	29.98	2155	28.58	670	27.85	345
50		4200	32.95	3570	30.24	2315	28.90	670	28.31	665
100		**4900**	**33.02**	**3580**	**30.46**	**2440**	**29.29**	**1115**	**28.78**	**670**
5	145+57	2300	32.56	3535	29.31	1145	26.88	270	25.51	175
10		3000	32.74	3550	29.66	1670	28.07	380	26.81	255

TABLE 3-1 Continued

GREEN LAKE CHANNEL IMPROVEMENTS
CALCULATED WATER SURFACE ELEVATIONS*

Tr (Year)	Cross Section Station	Q(cfs)	Existing Channel with Spillway Improvments		Existing Channel with Spillway, Railroad and Highway Improvments		Phase 1 Improvements		Phase 2 Improvements	
			CWSEL	TW	CWSEL	TW	CWSEL	TW	CWSEL	TW
25		3700	32.89	3565	30.00	2175	28.60	550	27.87	350
50		4200	32.95	3570	30.25	2345	28.92	670	28.33	460
100		**4900**	**33.03**	**3575**	**30.47**	**2495**	**29.31**	**1150**	**28.80**	**610**
5	146+06	2300	32.56	3735	29.33	1180	26.91	270	25.52	175
10		3000	32.74	3750	29.69	1740	28.09	665	26.83	260
25		3700	32.89	3765	30.03	2260	28.63	670	27.90	350
50		4200	32.96	3770	30.28	2630	28.95	670	28.35	665
100		**4900**	**33.03**	**3775**	**30.50**	**2955**	**29.34**	**1200**	**28.82**	**670**
5	146+96	2300	32.56	3235	29.37	1735	26.93	175	25.55	175
10		3000	32.75	3250	29.74	2120	28.11	180	26.85	180
25		3700	32.90	3265	30.08	2455	28.64	185	27.92	190
50		4200	32.96	3270	30.33	2635	28.95	185	28.37	190
100		**4900**	**33.03**	**3280**	**30.56**	**2795**	**29.35**	**250**	**28.83**	**195**
5	148+79	2300	32.57	3035	29.58	1800	26.97	135	25.59	175
10		3000	32.75	3050	29.92	2090	28.15	135	26.90	180
25		3700	32.90	3065	30.23	2385	28.68	135	27.96	190
50		4200	32.96	3070	30.45	2530	29.00	135	28.42	190
100		**4900**	**33.04**	**3080**	**30.67**	**2665**	**29.42**	**135**	**28.89**	**195**
5	153+20	2300	32.58	3710	30.05	2310	27.23	85	25.73	175
10		3000	32.76	3840	30.36	2585	28.41	85	27.05	180
25		3700	32.92	3945	30.63	2825	29.01	85	28.11	335
50		4200	32.98	3990	30.82	2995	29.37	85	28.59	350
100		**4900**	**33.06**	**4000**	**31.03**	**3165**	**29.86**	**85**	**29.09**	**365**
5	158+80	2200	32.58	6500	30.47	2815	27.73	50	25.87	175
10		2800	32.78	6500	30.73	3115	28.93	50	27.18	180
25		3500	32.93	6500	30.97	3395	29.64	50	28.26	190
50		4000	33.00	6500	31.14	4780	30.65	2565	28.74	190
100		**4600**	**33.09**	**6500**	**31.33**	**5160**	**31.11**	**4435**	**29.26**	**195**
5	159+40	2200	32.59	5925	30.52	2010	28.15	95	25.89	175

TABLE 3-1 Continued

GREEN LAKE CHANNEL IMPROVEMENTS
CALCULATED WATER SURFACE ELEVATIONS*

Tr (Year)	Cross Section Station	Q(cfs)	Existing Channel with Spillway Improvments		Existing Channel with Spillway, Railroad and Highway Improvments		Phase 1 Improvements		Phase 2 Improvements	
			CWSEL	TW	CWSEL	TW	CWSEL	TW	CWSEL	TW
10		2800	32.78	6190	30.77	2195	29.45	95	27.20	180
25		3500	32.93	6410	31.01	3735	30.39	1185	28.27	190
50		4000	33.00	6500	31.17	3960	30.80	1230	28.76	190
100		**4600**	**33.09**	**6500**	**31.36**	**4220**	**31.16**	**3945**	**29.28**	**195**

NOTES:

Starting water elevation for all flow frequencies are as follows unless otherwise noted:

5 Year	23.0 ft
10 Year	23.9 ft
25 Year	24.7 ft
50 Year	25.3 ft
100 Year	25.9 ft

Q(cfs) = future developed flows

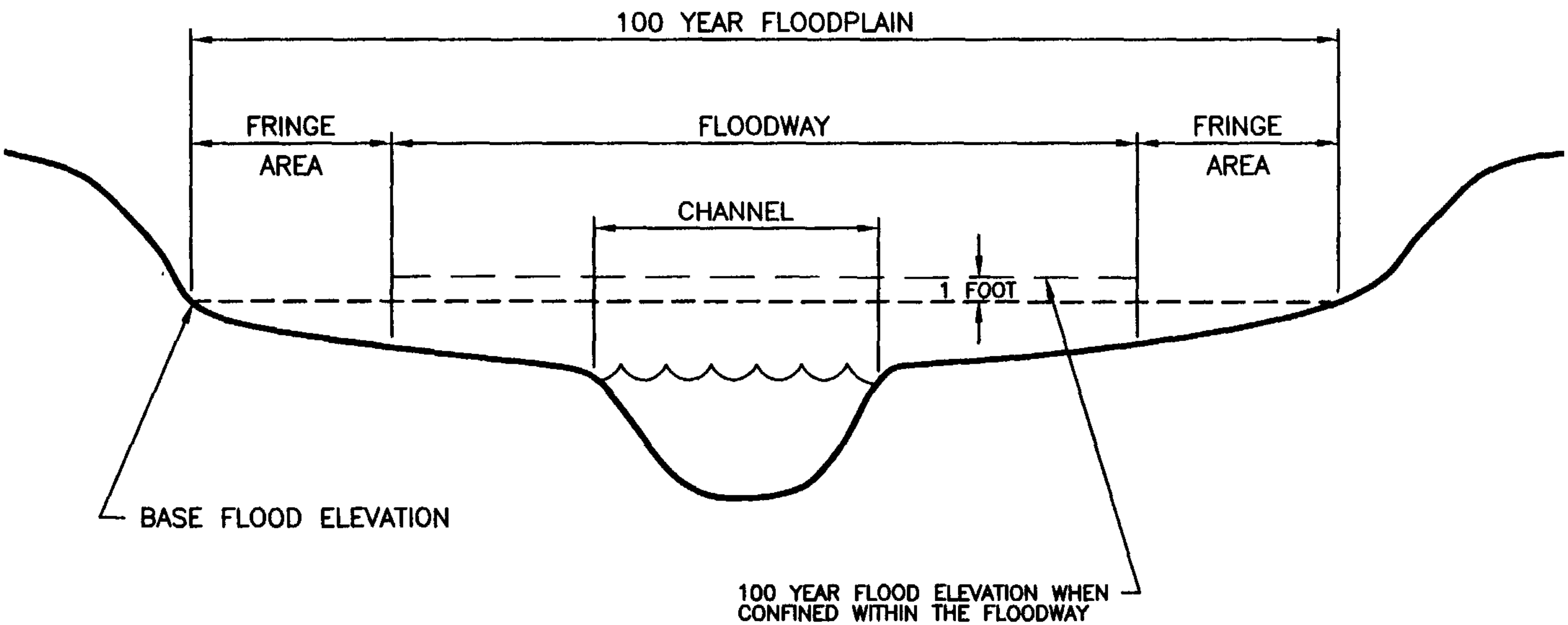
CWSEL = calculated water surface elevation

TW = top width

Due to constraints involving feasible starting water surface elevations and maximum channel widths, the 100-year target water surface elevation of 28.0 feet would not be obtained with the ultimate channel improvements. Phase II improvements would contain the lower frequency floods within the channel banks for the majority of the channel length. The 10-year and 5-year floods would be contained in their entirety within the channel banks with Phase II improvements.

3.6.2.3 Special Considerations

The floodway is a special portion of the floodplain which includes the main channel. The floodway fringe is considered to be the adjacent overbank areas (Figure 3-10). The floodway fringe results when portions of the floodplain are removed from the flow area on both sides of the stream channel. The removal of portions of the floodplain represent the effects of development in which portions of the floodplain are filled or blocked by other structures. Such obstructions are called encroachments on the floodplain. It is recommended that a floodway fringe be established as the limit on the amount of encroachment which will be allowed within the floodplain. Fill or other construction within the floodway fringe should be prohibited except in certain restricted situations. Removing portions of the floodplain area causes the water surface profile to rise. The National Flood Insurance Program requires that the floodway have sufficient capacity to convey the existing 100-year peak flow rate at a water surface profile that is 1.0 foot higher than the existing conditions 100-year water surface profile. It is recommended that more restrictive criteria be used for the Green Lake floodway due to the known flooding problems. Minimum finished floor slab elevations for future construction should also be established throughout the floodplain.



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NORTHSHORE PLANNING STUDY

FLOODPLAIN CROSS SECTION

FIGURE 3 - 10

E. BUSSEY	G. BRIDGES	NONE	3745-FP1	Sheet
G. BRIDGES	3745	3/94		of

3.6.3 Potential Environmental Impacts Due to Improvements

In general, the most likely direct impacts of proposed channel improvements may be to wetland/aquatic resources habitats and their associated wildlife. Endangered species are unlikely to be significantly affected by the improvements, but other species are known to occur in the project area. A detailed environmental impact analysis may be required in subsequent phases of project design in order to satisfy federal and state regulatory requirements.

A preliminary evaluation of U.S. Department of the Interior, Fish and Wildlife Service National Wetland Inventory Map, Gregory, Texas, indicated that estuarine and palustrine wetlands are two wetland types that may be affected by the project.

Field observations made on January 12, 1994 verified the presence of these wetland types. This identification was based on the vegetative and apparent hydrologic characteristics of the areas in and bordering Green Lake as well as those of areas below the dam structure. The presence of hydric soils was not evaluated but was inferred based on vegetative characteristics.

Although considered part of a storm drainage system, Green Lake is an impoundment around which wetland plant communities have become established to the point that an individual Corps of Engineers 404 permit will likely be required for construction of the project.

The potential for mitigation requirements for impacts to wetlands and aquatic habitats exists. Impacts may include conversion of shallow water habitat to deep water or dry land; potential loss of attendant floating, attached, emergent or fringe palustrine marsh vegetation; and potential conversion or loss of fringe palustrine wetland shrub communities. These losses may result from direct removal or alteration of water surface elevation. Similar direct and indirect impacts could affect estuarine wetlands and special aquatic habitats (e.g. oysters) below the dam.

A pre-application scoping meeting should be arranged with the U.S. Army Corps of Engineers and the Texas Natural Resource Conservation Commission early in the preliminary design phase to confirm all permitting requirements. In addition, due to the nature of the Green Lake system, final geometric design of floodway improvements should consider input from the environmental community as well as those involved in recreational use planning.

As with any action that affects an existing system, desired as well as unintended consequences may occur. Although the impacts are dependent on several factors currently unresolved at this time, potential effects may include:

- Impacts/Changes associated with decline in chlorinity ("Salinity")
  - * Decreased or delayed die back of floating and emergent aquaphytes (aquaphytes) during seasonal dry down and which may currently be caused by stress related to excess salinity in soil and water.
  - * Enhanced growth of aquaphytes potentially resulting in an annual increase in transpiration rates (resulting in a lower water level) in comparison to a dead/die back condition where the dead plant material acts as a mulch to retard evaporation.
  - * Depuration of salt-affected soils on lake margins allowing for colonization and growth by emergent aquaphytes. (Note: This presumes that soil salinity is a possible factor limiting emergent wetland plant establishment along exposed margins of Green Lake. Field observations suggest that there are differential fresh(er) water subterranean inflows from golf course irrigation and possible natural seepage which allow for the observed scattered presence of emergents.)
- Impacts/Changes due to stabilization of water surface
  - * Stabilization of water level to a specific range may enhance the colonization and growth of "preferred" emergents and effect a decline of the "less preferred" floating aquaphytes.

Plants are distributed within the Green Lake area in response to existing conditions. However, it is not specifically known if the distribution is a gross response to salinity, hydroperiod, both, or possibly other factors. Additional field observations, testing and cross-sectional elevation surveys at selected sites may be required during subsequent phases of project design to determine the relationship, if any, between surface elevation, inundation frequency or hydroperiod, soils or groundwater seepage salinity and species distribution under existing conditions. This "existing condition" information will be used in developing designs for proposed conditions. An evaluation of the need for soil borings to determine salinity and conductivity of soils and groundwater will also be required.

3.7 Flood Control Improvement Cost Estimates

Cost estimates for Phases I and II of the proposed Green Lake outfall system are presented in Tables 3-2 and 3-3, respectively. Phase I improvements that could be funded as part of the Northshore Project include reconstruction of the Green Lake spillway structure and channel excavation from Station 35+100 to Station 159+40.

Estimates are based on the assumption that channel excavation will be performed by the San Patricio County Drainage District over some period of time. For purposes of this cost estimate, the channel was divided into four (4) segments as follows:

Station	Estimated Construction Cost (Phase I)
35+00 to 75+00	$475,000
75+00 to 106+70	$494,000
106+70 to 138+10	$156,000
138+10 to 159+40	$136,000

It is anticipated that design and permitting would be completed for the entire project prior to any construction. The above segments could then be further subdivided and construction implemented in smaller stages, as dictated by available funding.

TABLE 3-2

COST ESTIMATE
PHASE I - GREEN LAKE CHANNEL IMPROVEMENTS

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount (Funded by Northshore Project)	Total Amount (Funded by Others)
Green Lake Spillway Structure:						
1.	Temporary Cofferdam Sheetpiles	SF	6000	$22	$132,000	---
2.	Temporary Cofferdam Earthen	LS	1	$10,000	$10,000	---
3.	Temporary Drainage Bypass	LS	1	$10,000	$10,000	---
4.	Excavation and Backfill	CY	12,000	$5	$60,000	---
5.	Demolition of Existing Structures	LS	1	$47,000	$47,000	---
6.	Concrete Stilling Basin	CY	320	$350	$112,000	---
7.	Vegetation Establishment	LS	1	$1000	$1000	---
8.	Concrete Spillway Structure	CY	512	$350	$179,000	---
9.	Bridge	SF	3200	$60	$202,000	---
	Sub-Total				$753,000	---
	Contingency (20%)				$151,000	---
	TOTAL ESTIMATED CONSTRUCTION COST				$904,000	---
Station 35+00 to 75+00:						
1.	Excavation and Disposal	CY	246,200	* $0.75	$185,000	---
2.	Vegetation Establishment	AC	30	$1,200	$36,000	---
3.	Clearing and Grubbing	AC	30	$700	$21,000	---
4.	Pipelines Crossings	LS	1	$100,000	$100,000	---
5.	Maintenance Road	SY	5340	$5	$27,000	---
	Sub-Total				$369,000	---
	Contingency (20%)				$74,000	---
	Easement Acquisition				$32,000	---
	TOTAL ESTIMATED CONSTRUCTION COST				$475,000	---

TABLE 3-2 Continued

COST ESTIMATE
PHASE I - GREEN LAKE CHANNEL IMPROVEMENTS

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount (Funded by Northshore Project)	Total Amount (Funded by Others)
Station 75+00 to 106+70:						
1.	Excavation and Disposal	CY	164,000	* $0.75	$123,000	---
2.	Vegetation Establishment	AC	24	$1,200	$29,000	---
3.	Clearing and Grubbing	AC	24	$700	$17,000	---
4.	Pipelines Crossings	LS	2	$100,000	$200,000	---
5.	Maintenance Road	SY	4230	$5	$21,000	---
	Sub-Total				$390,000	---
	Contingency (20%)				$78,000	---
	Easement Acquisition				$26,000	---
	TOTAL ESTIMATED CONSTRUCTION COST				$494,000	---
Station 106+70 to 138+10:						
1.	Excavation and Disposal	CY	87,000	* $0.75	$65,000	---
2.	Vegetation Establishment	AC	15	$1,200	$18,000	---
3.	Clearing and Grubbing	AC	15	$700	$11,000	---
4.	Maintenance Road	SY	4190	$5	$21,000	---
	Sub-Total				$115,000	---
	Contingency (20%)				$23,000	---
	Easement Acquisition				$18,000	---
	TOTAL ESTIMATED CONSTRUCTION COST				$156,000	---

TABLE 3-2 Continued

COST ESTIMATE
PHASE I - GREEN LAKE CHANNEL IMPROVEMENTS

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount (Funded by Northshore Project)	Total Amount (Funded by Others)
Station 138+10 to 159+40:						
1.	Excavation and Disposal	CY	99,000	* $0.75	$74,000	---
2.	Vegetation Establishment	AC	10	$1,200	$12,000	---
3.	Clearing and Grubbing	AC	10	$700	$7,000	---
4.	Maintenance Road	SY	2840	$5	$14,000	---
5.	SPRR Bridge	LF	270	$1,000	---	$270,000
6.	Northbound U.S. 181 Bridge	SF	8,000	$60	---	$480,000
7.	Southbound Entrance Ramp	SF	8,000	$60	---	$480,000
8.	Southbound Frontage Road	SF	8,000	$60	---	$480,000
9.	Concrete Slope Paving	SF	37,600	$4	---	$150,000
	Sub-Total				$107,000	$1,860,000
	Contingency (20%)				$21,000	$372,000
	Easement Acquisition				$8,000	---
	TOTAL ESTIMATED CONSTRUCTION COST				$136,000	$2,232,000

COST SUMMARY:

Green Lake Spillway	$ 904,000
Station 35+00 to 75+00	$ 475,000
Station 75+00 to 106+70	$ 494,000
Station 106+70 to 138+10	$ 156,000
Station 138+10 to 159+40	$ 136,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,165,000
Professional Services (14%)	$ 303,000
TOTAL PROJECT CAPITAL COST	**$2,468,000**
ANNUAL COSTS	
Debt Service	$ 251,000

*Based on excavation performed by San Patricio County Drainage District and spreading of disposal on adjacent land.

TABLE 3-3

COST ESTIMATE
PHASE II - GREEN LAKE CHANNEL IMPROVEMENTS

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount (Funded by Northshore Project)
Station 35+00 to 75+00:					
1.	Excavation and Disposal	CY	69,000	* $1.00	$69,000
	Sub-Total				$69,000
	Contingency (20%)				$14,000
	SUB-TOTAL ESTIMATED CONSTRUCTION COST				$83,000
Station 75+00 to 106+70:					
1.	Excavation and Disposal	CY	45,000	* $1.00	$45,000
	Sub-Total				$45,000
	Contingency (20%)				$9,000
	SUB-TOTAL ESTIMATED CONSTRUCTION COST				$54,000
Station 106+70 to 138+10:					
1.	Excavation and Disposal	CY	42,000	* $1.00	$42,000
2.	Vegetation Establishment	ACRE	15	$1,200	$18,000
	Sub-Total				$60,000
	Contingency (20%)				$12,000
	SUB-TOTAL ESTIMATED CONSTRUCTION COST				$72,000
Station 138+10 to 159+40:					
1.	Excavation and Disposal	CY	66,000	* $1.00	$66,000
2.	Vegetation Establishment	ACRE	10	$1,200	$12,000
	Sub-Total				$78,000
	Contingency (20%)				$16,000
	SUB-TOTAL ESTIMATED CONSTRUCTION COST				$94,000
COST SUMMARY:					
	Station 35+00 to 75+00				$ 83,000
	Station 75+00 to 106+70				$ 54,000
	Station 106+70 to 138+10				$ 72,000
	Station 13810 to 159+40				$ 94,000
	TOTAL ESTIMATED CONSTRUCTION COST				$303,000
	Professional Services (16%)				$ 50,000
	TOTAL PROJECT CAPITAL COST				**$353,000**
	ANNUAL COSTS				
	Debt Service				$ 36,000

The project cost for the Green Lake Spillway reconstruction, including professional services, is estimated to be approximately $1.0 million, which would require an annual debt service of approximately $102,000 (based on 20-year loan at 8 percent interest rate). It is anticipated that reconstruction of the spillway structure would be performed by a contractor selected through the competitive bidding process.

Construction cost estimates for improvements to railroad and highway structures that cross the Green Lake channel in the segment from Station 138+10 to Station 159+40 are estimated at $2,232,000 (Table 3-2). Hydraulic improvements to these structures were included in the HEC-2 analyses. Contact will need to be made with the appropriate entities to coordinate their construction of the required improvements with the overall project.

Phase II improvements that could be funded as part of the Northshore Project include additional channel excavation from Station 35+00 to Station 159+40 and are summarized below:

Station	Estimated Construction Cost (Phase II)
35+00 to 75+00	$83,000
75+00 to 106+70	$54,000
106+70 to 138+10	$72,000
138+10 to 159+40	$94,000

The costs of annual maintenance are not included in the cost estimates presented above. Maintenance requirements for the entire improved channel from Station 35+00 to Station 159+40 are estimated to include one dragline and operator for approximately two months per year. This total maintenance cost is estimated to range from $15,000 to $20,000/year.

3.8 Benefit-Cost Analyses

General guidelines for the performance of benefit-cost analyses have been obtained from Economic and Environmental Principles and Guidelines for Water Related Land Resources Implementation Studies (Ref. 14) prepared by the U.S. Water Resources Council (WRC). The applied benefit-cost evaluation methodology and assumptions and estimation of average annual flood damages for the Green Lake area are discussed and specific unit costs and unit benefits are assigned in the following sections.

3.8.1 Methodology and Assumptions

The WRC suggests that there are three basic types of benefits associated with the reduction of flood damages: 1) inundation reduction benefits for which land use type and intensity remain the same with the project as without; 2) intensification benefits for which land use type remains the same and intensity increases with the project; and 3) location benefits for which a new land use type is allowed as a result of project implementation. All three types of benefits have been considered either directly or indirectly in the evaluation of the proposed Green Lake outfall system for the Northshore Planning Study. Project benefits are related to the reduction of physical damages including damages to property, structures, contents, crops, automobiles, utilities, and public amenities. Reductions in emergency costs related to evacuation, flood fighting, rescue, reoccupation, clean-up, and general public safety during flood events are also considered project benefits. Benefits may also be attributed to the increase in property value and development potential of land removed from the floodplain by project implementation.

The 100-year flood was selected as the design flood for the preliminary design and evaluation of the flood control project in this study. A 20-year project life has been assumed for the amortization of benefits and costs. Benefit-cost ratios for the project are evaluated for both existing and future conditions. Physical flood damages were evaluated on a per acre basis, and these unit damages are based on county-wide averages for San Patricio County urban and rural areas obtained from available flood damage estimates for historical flood events. Emergency costs are assumed proportional to total flood damage estimates. Future project benefits (including intensification and location benefits) are assumed to be reflected primarily in the increase in property value of land removed from the floodplain.

The procedure applied in the performance of benefit-cost analyses for the Northshore Planning Study is presented as follows:

- Delineate the 100-year floodplain both with and without the project;
- Classify acreage removed from the floodplain by project implementation as urban or rural and compute flood damage reduction benefits;
- Estimate average annual flood damage reduction benefits based on the ratio of average annual damages to estimated 100-year damages for San Patricio County;
- Estimate reduction in emergency costs at 5.0 percent of the average annual flood damage reduction. The ratio of emergency costs to total flood damage was approximately five percent for Hurricane Beulah (Ref. 12), which caused severe flooding in Texas coastal areas in 1967;
- Evaluate capital project costs including contingencies (20 percent of basic construction costs) and allowance for engineering, legal, administration, and finance fees (14 to 16 percent of total construction cost including contingencies);
- Estimate annual maintenance costs. Maintenance requirements for the entire improved channel from Station 35+00 to Station 159+40 are estimated to include one dragline and operator for approximately 2 months per year. This total maintenance cost is estimated to range from $15,000 to $20,000/year.
- Compute annual project cost based on a 20-year project life and an 8 percent interest rate;

- Classify rural acreage removed from the floodplain by project implementation as having urban development potential, enhanced development potential, or no significant development potential;
- Estimate average annual potential development benefits and add to annual flood damage and emergency cost reduction benefits; and
- Compute benefit-cost ratio for future conditions.

Benefits and cost estimates presented in this report are prepared for conceptual and comparative purposes only.

Specific channel and structural improvements are provided herein to define the hydraulic characteristics required to assess flood damage reduction benefits and estimate the costs of improvements. Final determination of these features and associated costs cannot be made until a detailed engineering design has been completed.

3.8.2 Average Annual Flood Damages

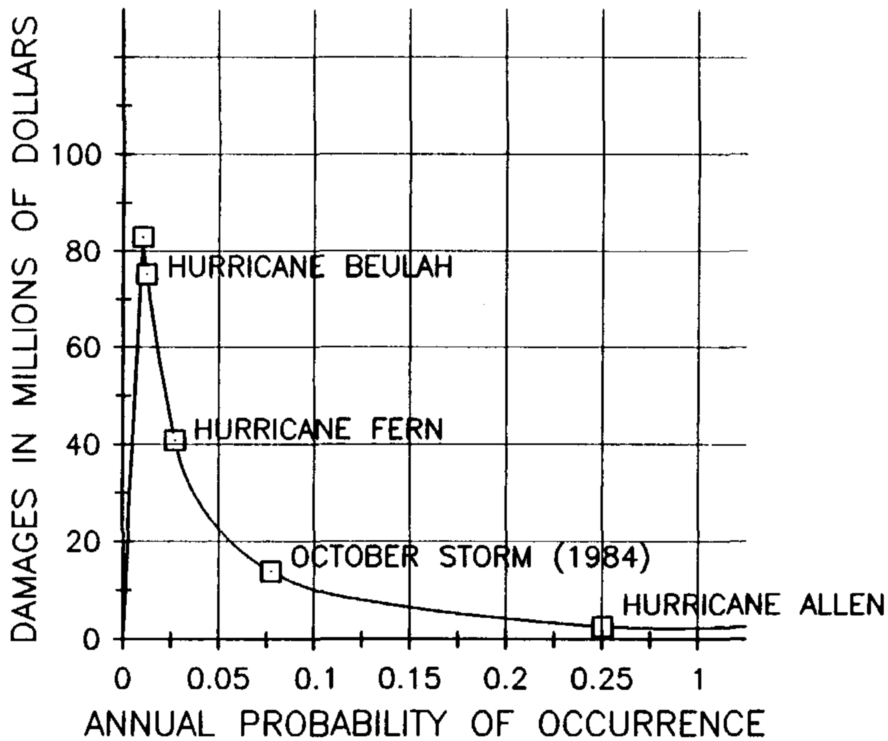
Average annual flood damages for San Patricio County were estimated based on historical flood damage estimates for significant storm events. Key references containing information regarding historical flood damages in the County included the "Report on Hurricane Beulah" issued by the U.S. Army Corps of Engineers (Ref. 12), and the 1987 San Patricio Flood Control Study (Ref. 6). Damage estimates are available for four major events including Hurricanes Beulah, Fern, and Allen and the so-called "October Storm" of 1984; these were considered in the estimation of average annual damages. The return periods of major flood events were based on the frequency distribution of annual maximum discharges observed at the USGS gage on Chiltipin Creek at Sinton (Figure 3-11). Damage estimates were converted to 1992 dollars based on historical per capita income in San Patricio County obtained from the Texas Employment

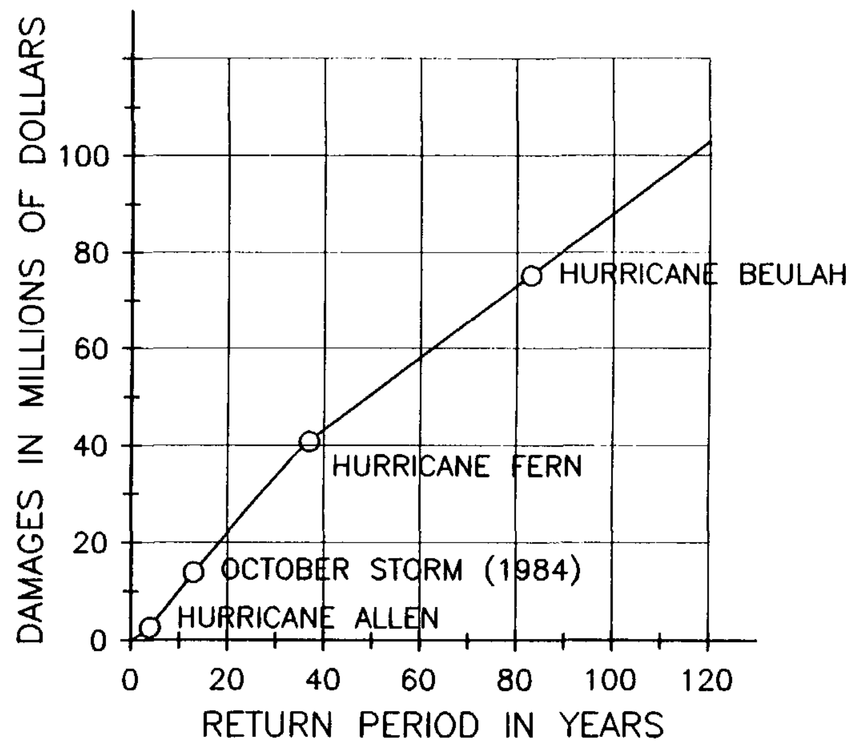
Commission (TEC) and the 1987 Flood Control Study (Ref. 6). Plotting damages versus return period, county-wide flood damages for the 100-year event were estimated to be approximately $83.0 million. Average annual flood damages for San Patricio County were estimated at $4.81 million by plotting damages versus frequency and computing the area under the curve (Figure 3-11). San Patricio County wide data were utilized since specific flood damage information for the Northshore area was not available.

3.8.5 Economic Evaluation

An economic evaluation of the recommended channel and structural improvements for the Green Lake outfall system was prepared in the form of benefit-cost analyses (Table 3-4). A detailed cost estimate for these improvements is included in Section 3.7, Table 3-3. Table 3-5 summarizes the applicable unit benefits attributable to the proposed channel improvements. The analysis shows that the existing and future development benefit-cost ratios for the 100-year event are 0.6 and 0.8, respectively. Although both benefit-cost ratios are less than unity, the analysis does not take into account other types of benefits, both economic and non-economic. Cost utilized in calculating the benefit-cost ratios include costs attributed to the Northshore Project and railroad/highway structure modification costs to be borne by others. It if is assumed that the railroad/highway improvements will be funded by others and those costs are not included in the benefit-cost ratios, existing and future development benefit-cost ratios for the 100-year flood are 1.0 and 1.4, respectively.

Benefits for the recommended flood control improvements could become more apparent for the more frequent storm events. As mentioned in Section 3.6.1.3, computed water surface





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NORTHSHORE PLANNING STUDY

PROBABILITY DISTRIBUTION OF FLOOD DAMAGES

FIGURE 3 - 11

E. BUSSEY	G. BRIDGES	NONE	3745–CH4
E. TRINIDAD	3745	4/94	

TABLE 3-4
ECONOMIC EVALUATION
GREEN LAKE CHANNEL IMPROVEMENTS

	Average Annual Dollars
Benefits:	
Flood Damage Reduction	$293,000
Emergency Cost Reduction	15,000
Total Benefits - Existing Conditions	308,000
Potential Development Benefits	105,000
Total Benefits - Future Conditions	413,000
Costs:	
Proposed Channel and Spillway Improvements (Phase I and II)	287,000
Maintenance (Funded by Northshore Project)	15,000
Subtotal	302,000
Recommended Railroad and Highway Structure Improvements (Funded by Others)	227,000
TOTAL	529,000

BENEFIT-COST RATIO
Cost of Northshore Project Funding Only Existing Conditions = 1.0 Future Conditions = 1.4
Total Cost (Northshore Project Funding and Funding by Others) Existing Conditions = 0.6 Future Conditions = 0.8

TABLE 3-5
FLOOD PROTECTION UNIT BENEFITS*

Item	Unit Benefit**	Explanation
Urban Flood Damage Reduction	$42,000.00	Based on historical urban flood damages and 3.25 structures per acre in Gregory/Portland area.
Rural Flood Damage Reduction	$300.00	Based on historical rural flood damages to agricultural property.
Potential Urban Development Benefit	$2,400.00	Location/intensification benefit assigned to area credited with development potential in estimation of project cost.
Potential Development Benefit	$1,200.00	Location/intensification benefit assigned to currently undeveloped (or agricultural) area.

*Unit benefits are in dollars per acre removed from the 100-year floodplain as a result of project implementation.
**Expressed in 1993 prices.

elevations show the 5-year and 10-year floods would be contained within the channel banks. The proposed channel and structural improvements would remove some developed area from the flood plain, thus flood damages to existing development in the area would be reduced. In addition, there would be benefits provided by the proposed greenbelt, such as water quality enhancement and recreational and ecological values for which economic benefits were not estimated due to lack of data.

4.0 POTENTIAL WATER SUPPLY ENHANCEMENT THROUGH WASTEWATER REUSE

4.1 Effects of Wastewater Reuse Upon the Choke Canyon/Lake Corpus Christi System Yield

The Choke Canyon/Lake Corpus Christi Reservoir System (CC/LCC System) is the primary source of water for the San Patricio County study area. The CC/LCC Reservoir System plus Nueces River flows from the drainage area below Lake Corpus Christi supply raw water to the pool formed by Calallen Dam near the mouth of the Nueces River. Municipal, industrial, and irrigation water supplies for Corpus Christi, the San Patricio County Municipal Water District, the Nueces County Water Control and Improvement District Number 3, and others are diverted from the Calallen pool. The Texas Natural Resource Conservation Commission (TNRCC) permit for development of Choke Canyon Reservoir contains special conditions which require that not less than 151,000 acre-feet of water per year be supplied to the receiving estuaries through a combination of return flows, spills, and releases[5]. These receiving estuaries include Nueces, Corpus Christi, Oso, and Redfish Bays as well as a portion of Laguna Madre. An interim order issued March 9, 1992 by the Texas Water Commission (predecessor to TNRCC) established a set of operational guidelines in an effort to ensure that at least 97,000 acre-feet of freshwater per year would be provided to Nueces Bay through treated effluent, natural runoff downstream of the CC/LCC System, and spills and releases from the CC/LCC System. Freshwater inflows to Nueces Bay could be affected by the wastewater reuse project being considered in this study as the City of Portland currently discharges 1.11 mgd (1,240 acre-feet per year) of treated effluent to Nueces Bay. In the wastewater reuse project considered as part of this study, Portland's effluent along with effluent from other cities in the study area,

[5]Certificate of Adjudication No. 21-3214, Texas Natural Resource Conservation Commission, Austin, Texas.

would be reused and no longer be discharged to Nueces Bay, provided such project is economically feasible and approved by regulatory agencies.

One industrial customer (Reynolds Metals) of the San Patricio Municipal Water District (SPMWD) now uses about 2.8 mgd (3,135 acre-feet) of raw water per year for purposes which could be met with municipal wastewater. If raw water now being used by industry were replaced with municipal wastewater effluent, then present demands upon the CC/LCC System would be reduced by the quantity of municipal wastewater effluent that is substituted for raw water from the system. However, since some (Portland's wastewater) of the municipal wastewater effluent being considered for industrial reuse is now being discharged to Nueces Bay and is credited toward the monthly inflow quantities specified by the TNRCC interim order referenced above, it is necessary to evaluate the effects upon the yield of the CC/LCC System of reducing effluent discharges into Nueces Bay. Under the TNRCC interim order, CC/LCC releases might have to be increased to offset the credit being obtained from the wastewater effluent that would be shifted from the bay to industrial use. These CC/LCC yield effects were calculated using a simulation model of the Lower Nueces River Basin and Estuary, including the CC/LCC System, that was developed by HDR under contracts with the City of Corpus Christi. The model operates on a monthly time step over a 1934-89 period of record. Computations in the model simulate evaporation losses from the reservoirs as well as channel losses in the delivery of water from Choke Canyon Reservoir (CCR) to Lake Corpus Christi (LCC), and from LCC to Calallen diversion dam. In addition, the model computes the firm yield of the reservoir system given the operating policy and other institutional requirements imposed on the system. The firm yield is defined as the maximum, annual quantity of water that can be reliably drawn from the system during the worst drought of record. The computations are presented below.

Under the Corpus Christi Phase II and Phase IV operating policies for the CC/LCC System, the effect of diverting Portland's 1.11 mgd (1,240 acre-feet per year) of wastewater to industrial use would increase the water supply from the CC/LCC System by 540 acre-feet per year[6]. For example, the use of 1,240 acre-feet of wastewater effluent by industry reduces the demand upon the CC/LCC System by 1,240 acre-feet. However, the reduction of wastewater discharges to Nueces Bay of 1.11 mgd (1,240 acre-feet) per year would require additional releases from the CC/LCC System which reduces the system yield by 700 acre-feet per year. The net effect of the reduced yield (700 acre-feet per year) and the reduced use of water from the CC/LCC System (1,240 acre-feet per year) for industrial purposes is 540 acre-feet per year (1,240 minus 700 equals 540).

4.2 Comparison of Alternative Methods of Collection, Treatment, and Delivery of Wastewater Effluent for Industrial Use to that of Development of Raw Water Supplies

As discussed in the previous section, the diversion of Portland's wastewater effluent discharge from Nueces Bay to a regional wastewater facility near Reynolds Metal Company decreases the firm yield of the CC/LCC System. However, under the regional wastewater plan detailed in this study, wastewater from the new regional plant will be supplied to Reynolds in place of a portion of their current raw water use. This will decrease Reynolds' dependence on freshwater from the reservoir system via San Patricio Municipal Water District (SPMWD).

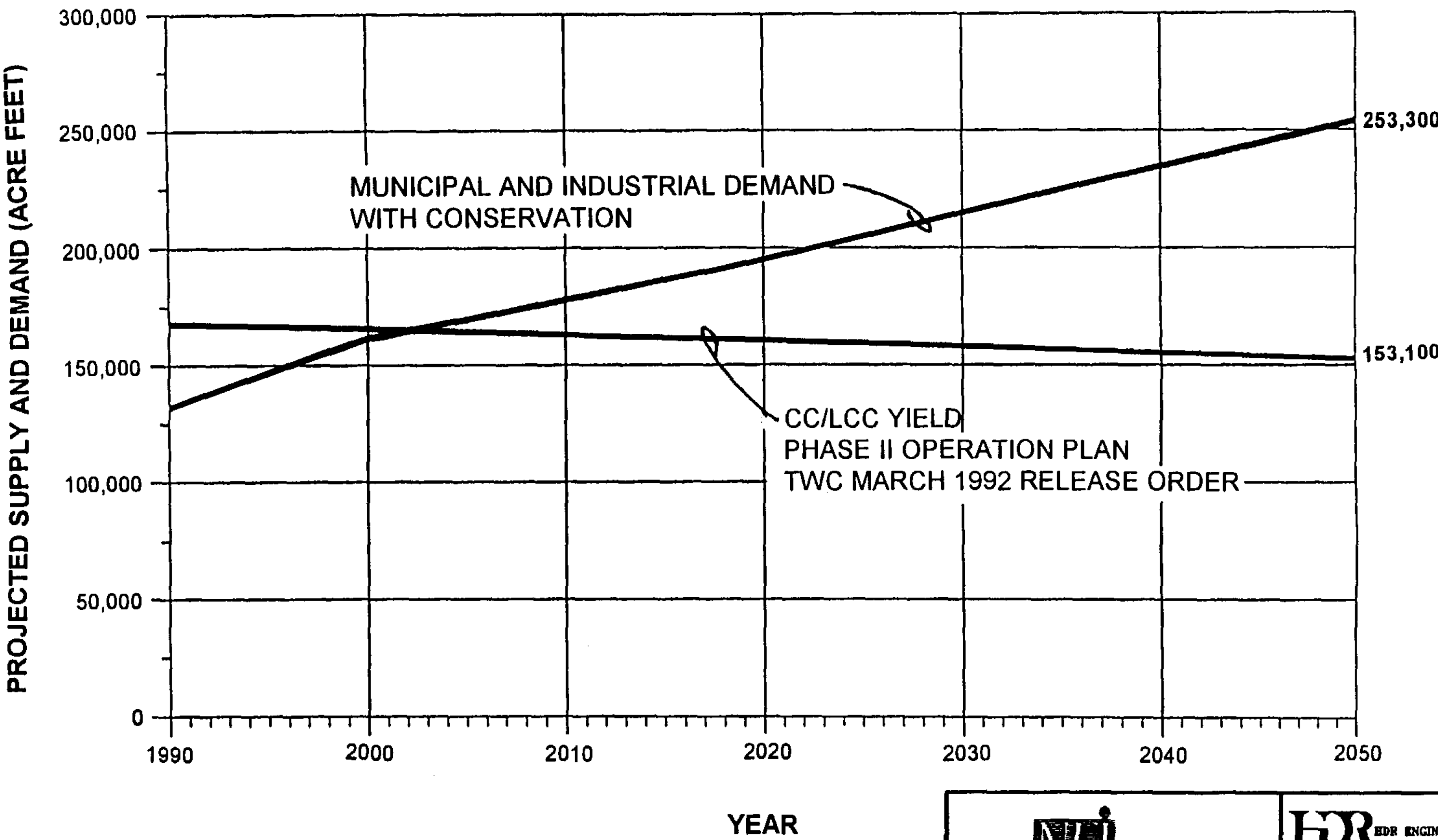
In 1993, from January through August, SPMWD sold an average of 2.8 mgd (3,135 acre-

[6]A minimum of 2,000 acre-feet per month is released from Choke Canyon. Under the Phase II policy, the goal is to use releases from Choke Canyon to maintain the water surface elevation in Lake Corpus Christi at 88 feet-msl, while, under the Phase IV policy, the Lake Corpus Christi water surface elevation would be allowed to drop to 76 feet-msl before water would be released from Choke Canyon in excess of the 2,000 acre-feet per month.

feet per year) of raw water to Reynolds for use in their processing facility and irrigation of their tailing ponds. Under a regional wastewater reuse plan, the raw water used by Reynolds could be replaced by effluent from a regional wastewater treatment plant, using wastewater from the cities of Portland, Gregory, Aransas Pass, and Ingleside (2.89 mgd in year 2000). This decrease in demand at Reynolds would, in turn, decrease SPMWD's demand on the CC/LCC System. The increase in water available for SPMWD could be as high as 3,135 acre-feet per year (Reynolds' current raw water use); a volume more than four times the impact on CC/LCC System firm yield when Portland effluent is no longer discharged to Nueces Bay. (Note: Of the potential participants, only Portland discharges to Nueces Bay.)

The City of Corpus Christi supplies water to users in seven counties surrounding the CC/LCC Reservoir System. Corpus Christi and surrounding areas are experiencing rapid growth. Current demands on the CC/LCC System for water supply total approximately 132,000 acre-feet per year, and, if current growth rates continue, population projections indicate an annual demand of approximately 253,000 acre-feet by the year 2050. Under current reservoir operation policies, the CC/LCC System yield may not be adequate to meet the demands of the current supply area shortly after the turn of the century (Figure 4-1). For these reasons, Corpus Christi has been identifying and evaluating additional water supply options for itself and its customers.

The most recent water supply study in this area is the Trans-Texas Water Program - Corpus Christi Service Area Study, Phase I. Objectives in this study were to quantify potential future demands, to identify potential water supply options, and to evaluate and assess these options and make recommendations as to which options appear most favorable. In this Trans-Texas Study, ten options involving augmentation of the CC/LCC System and other local



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MUNICIPAL AND INDUSTRIAL WATER DEMAND AND SUPPLY PROJECTIONS - CHOKE CANYON/LAKE CORPUS CHRISTI SYSTEM

FIGURE 4 - 1

Project No.: 3745 Date: 5/94

potential raw water supply options were identified and evaluated. A summary of these options and their unit costs are listed in Table 4-1. The projects are ranked in the table from least unit cost to greatest unit cost. It should be noted that the evaluation of these options was based on their increase in the CC/LCC System's firm yield delivered to the O.N. Stevens water treatment plant located at the Calallen Diversion Dam. Therefore, the costs associated with each alternative in Table 4-1, except Northshore Wastewater Reuse, do not include delivery to the San Patricio Municipal Water District's service area. Annual costs for a new 36-inch, 28-mile water line from Calallen to the SPMWD's Water Treatment Plant are estimated at $2.156 million. At full operation, such a line could deliver 21,487 acre-feet per year, at a unit cost of $108 per acre-foot per year (Table 4-2).

In comparison to the water supply alternatives being considered in other studies, wastewater reuse compares quite favorably. For example, the quantity available from the collection and reuse of Portland, Gregory, Aransas Pass, and Ingleside effluent is approximately 3,237 acre-feet per year at an estimated cost of $461 per acre-foot per year (Table 4-1). This is about 23 percent of the present level of use form the SPMWD's facilities which in 1993 was about 13,956 acre-feet (Table 2-9). In addition, this water is already at the point of use and does not have to be pumped 28 miles at a cost of $108 to $172 per acre-foot, as would be the case for other sources delivered to the Calallen diversion point (Table 4-2).

TABLE 4-1
SUMMARY OF RAW WATER AND WASTEWATER REUSE ALTERNATIVES IN THE CORPUS CHRISTI RAW WATER SERVICE AREA

Alternative	Year 2050 Additional Water Supply (Ac-Ft/Yr)*	Unit Cost of Additional Water 1993 Dollars ($/Ac-Ft/Yr)[1]
Modify Existing Reservoir Operating Policy[2]	7,200	0
Wastewater Reuse in the Nueces Delta[3]	16,500	56
Purchase of Existing Water Rights in Nueces Basin	3,300	< 100
Use of Groundwater from Campbellton Wells (Carrizo Aquifer)	4,800	243
Pipeline from Lake Texana to O.N. Stevens Water Treatment Plant (WTP) with Garwood included	31,440	303*
Pipeline from Garwood Irrigation Co. (Colorado Basin) to O.N. Stevens WTP with Lake Texana included	29,000	374
Northshore Wastewater Reuse	3,237[5]	461[4]
Pipeline from Choke Canyon to Lake Corpus Christi	18,000	614
Local Brackish Ground Water Options	(?)	650
Pipeline from Lake Corpus Christi to Calallen	6,500	663
Desalination	> 100,000	1,400

*"Trans-Texas Water Program, Corpus Christi Service Area, Phase I Interim Report," Lavaca-Navidad River Authority, Corpus Christi, Port of Corpus Christi, Corpus Christi Board of Trade, and Texas Water Development Board, Edna, Texas, August, 1993.
[1]Does not include cost of pumping water about 28 miles from Calallen to SPMWD's system, which for a new pipeline could range from $108 to $172 per acre-foot, depending upon volume pumped.
[2]Yield amount based on the City's Phase IV Operating Policy with Target level = 86.0 feet msl.
[3]Yield amount based on wastewater multiplier of 5 and river water multiplier of 3 with respect to Nueces Bay inflow requirements specified in the TNRCC interim order.
[4]Is already at point of use, thus footnote 1 does not apply.
[5]See Table 2-18.

TABLE 4-2
ESTIMATED COSTS FOR 36-INCH, 28-MILE PIPELINE FROM CALALLEN TO SAN PATRICIO MUNICIPAL WATER DISTRICT[1]

Item No.	Description	Unit Cost	Total Cost
01	Pipeline (28 miles; 36-inch)	$77/ft	$9,760,000
02	Pump Station Boosters	--	1,600,000
03	Subtotal		12,984,000
04	Engineering, Legal, Contingencies (25%)	--	2,840,000
05	Subtotal		15,824,000
06	Environmental and Economic	--	150,000
07	Subtotal		15,974,000
08	Interest During Construction	--	430,000
09	TOTAL		$16,404,000
	Annual Costs		
	Debt Service (10%)		$1,674,000
	Operation & Maintenance		148,000
	Power		500,000
	TOTAL		$2,322,000

[1]Sized to meet projected demands of 21,487 acre-feet per year in addition to present demands of 13,444 acre-feet per year being met with existing pipelines.

5.0 COST SUMMARY OF ALTERNATIVES STUDIED

5.1 Potential Cost Savings from Wastewater Reuse

The potential cost savings from wastewater reuse are due to deferred construction of additional water supply facilities and possible elimination of requirements for municipal wastewater treatment plant upgrades.

As presented in Section 4.2, annual costs for a new 36-inch, 28-mile water line from Calallen to the SPMWD's Water Treatment Plant are estimated at $2.322 million. Deferment of this cost for a period of time could be accomplished through reuse of municipal effluent to meet a part of the study area's industrial freshwater needs and free up for other uses an equivalent quantity of freshwater that is now used by industry. Wastewater treatment plant costs presented in Section 2.0 reflect savings that can be obtained by diversion of effluents from their current discharge points. For example, City of Portland wastewater treatment plant cost savings would include elimination of the need for installation of dechlorination facilities and elimination of the need for any future plant upgrades to meet more stringent effluent limitations. Additional cost savings that were not directly included in the economic analyses include future increases in labor, operations, and maintenance costs, increasing administration costs for cities, and costs associated with new rules and regulations.

5.2 Costs for Northshore Country Club Irrigation Water

Section 2.4.1.1 contains a description of the impact of the proposed Green Lake Dam flood control modifications and lack of a firm yield on North Shore Country Club's irrigation operations. Four water supply scenarios were described which would allow NSCC to continue to meet their irrigation demands. Table 5-1 summarizes costs for each of the scenarios, as well as their present operation, on an annual basis.

TABLE 5-1
COST SUMMARY FOR NSCC IRRIGATION WATER DELIVERY SCENARIOS

Item		Capital Cost	Annual Cost
Present Operation	Water purchased from COP (51 acft)		$17,684
	Modify Green Lake intake	$10,000	$800
	Irrigation system O&M		$20,000
	Total Annual Cost		$38,484
Scenario 1A	Water purchased from COP (79 acft)		$26,897
	Modify Green Lake intake	$15,000	$1,530
	Irrigation system O&M		$20,000
	Total Annual Cost		$48,427
Scenario 1B	Water purchased from COP (93 acft)		$31,824
	Modify Green Lake intake	$15,000	$1,530
	Irrigation system O&M		$18,000
	Total Annual Cost		$51,354
Scenario 2A	Regional primary plant	$400,000	$40,800
	O&M for regional primary		$12,000
	Regional secondary plant	$750,000	$76,500
	O&M for regional secondary		$20,000
	Pump/pipeline system	$320,000	$32,640
	Total Annual Cost		$181,940
Scenario 2B	O&M for pump/pipeline		$8,000
	Lined storage pond	$170,000	$17,340
	Irrigation modifications	$25,000	$2,550
	Water purchased from COP (18 acft)		$6,000
	O&M for irrigation system		$20,000
	Total Annual Cost		$236,000
Scenario 3A	New check dam	$165,000	$16,830
	New intake/pump	$50,000	$5,100
	O&M for above		$5,000
	Water purchased from COP (22 acft)		$7,528
	O&M for irrigation system		$20,000
	Total Annual Cost		$54,458
Scenario 3B	New check dam	$165,000	$16,830
	New intake/pump	$50,000	$5,100
	O&M for above		$5,000
	Water purchased from COP (31 acft)		$10,608
	O&M for irrigation system		$18,000
	Total Annual Cost		$55,538
Scenario 4A	Water purchased from SPMWD		$8,110
	Modify Green Lake intake	$15,000	$1,530
	Irrigation system O&M		$20,000
	Total Annual Cost		$29,640
Scenario 4B	Water purchased from SPMWD		$9,547
	Modify Green Lake intake	$15,000	$1,530
	Irrigation system O&M		$18,000
	Total Annual Cost		$29,077

Based on the summary of annual costs, Scenario 4 is the best option for meeting NSCC irrigation needs after construction of the Northshore project (Table 5-1).

5.3 Property, Easement and Right-of-Way (ROW) Acquisition for Wastewater Treatment and Transmission Systems

Proposed facilities that will require acquisition of property, easements or ROW include effluent mains, effluent pump stations, force mains, wastewater pump stations and the regional WWTP. Cost estimates presented in Section 2 included an assumed unit cost of $2,000 per acre for easement or property acquisition. Effluent main and force main easements were assumed to be 20 feet wide.

Easement requirements for effluent mains from each city to the Reynolds Metals tailings beds or force mains from each city to the regional WWTP are based on preliminary routings as described below. Final routings will be determined during subsequent phases.

<u>Portland</u>:

- Routing is based on the assumption that the effluent main or force main will be located within existing Broadway Boulevard ROW from the Main Plant in an easterly direction to Railroad Avenue or within a utility easement (UE) parallel to Broadway Boulevard.

- From the intersection of Railroad Avenue and Broadway Avenue, a UE will be required from Southern Pacific Railroad (SPRR), extending in a northeasterly direction to the existing pipeline corridor south of Northshore Boulevard. (It is possible that the City of Portland UE to be obtained during abandonment of the Northshore WWTP may be shared in this area).

- The routing eastward is based on the assumption that the effluent main or force main will be located within an existing UE that parallels the pipeline corridor in an easterly direction to Broadway Boulevard near the NSCC Clubhouse.

- From that point, a UE is assumed to be required that parallels existing and future Broadway Boulevard ROW in a northerly direction to the existing Oak Ridge Ditch ROW.

- A new UE will be required on the north side of Oak Ridge Ditch ROW, that parallels the ditch in an easterly direction to the Green Lake channel easement.

- East of the Green Lake channel, a new UE will parallel the existing SPMWD pipeline easement to the existing gravel road and drainage swale west of the Reynolds site.

- The UE will then parallel the drainage swale northward to the regional WWTP site.

<u>Gregory</u>:

- From the WWTP, the effluent main or force main will be located in a UE that parallels Sunset Road and the Green Lake Channel to U.S. 181 ROW.

- East of U.S. 181, the UE will parallel the Green Lake Channel for a distance of approximately 3,000 feet.

- At the point where the channel turns south, the UE will continue across an existing agricultural field to the existing gravel road and drainage swale west of the Reynolds site.

- The UE will then parallel the drainage swale southward to the regional WWTP site.

<u>Aransas Pass</u>:

- From the Ransom Island Pump Station, the routing is based on the assumption that the effluent main or force main may be located within existing Euclid Street ROW in a southerly direction to Highland Avenue.

- The routing will parallel Highland Avenue westward for approximately 14,000 feet to Avenue B (FM 1069). It is possible that portions of the line may be located within existing ROW. Cost estimates were based on the requirement of an easement parallel to Highland Avenue for the entire routing.

- Routing is then generally southward, paralleling FM 1069 for approximately 7,500 feet.

- Preliminary routing is based on the assumption that the line will be located within a UE that bears in a northwesterly direction, perpendicular to FM 1069 for approximately 3,800 feet, then turns in a southwesterly direction parallel to FM 1069 for approximately 5,600 feet to the north side of the SPRR ROW north of SH 361, approximately 3,800 feet west of the intersection of SH 361 and FM 1069.

- A UE will be required from that point, in a northwesterly direction parallel to SH 361 to a point approximately 1,000 feet east of SH 35.

- The line will then cross the SPRR and SH 361 ROW to the Reynolds site and discharge at the tailings beds (effluent main) or extend around the perimeter of the site to the regional WWTP site west of Reynolds.

Ingleside:

- From the WWTP, the routing is based on the assumption that the effluent main or force main will be located in a UE parallel to Eighth Street west of the plant to a point approximately 800 feet west of Avenue B.

- From that point, the routing is assumed to turn northward to a point approximately 4,000 feet south of SH 361, then westward and parallel to SH 361 to a point approximately 4,000 feet west of FM 1069.

- The routing then extends in a northerly direction, crossing SH 361 and SPRR ROW to a point of connection with the Aransas Pass lines.

- The line then follows the same routing as described for Aransas Pass, from this point to Reynolds.

Taft:

- From LS #3, the routing is assumed to require a UE and extend in an easterly direction parallel to (and approximately 1 mile north of) U.S. 181 to a point approximately 1,000 feet east of SH 35.

- The routing then extends southward, parallel to SH 35, and crosses the SPRR ROW and FM 361 to Reynolds or the regional WWTP site west of Reynolds.

Sinton:

- From Taft's LS #3, the routing extends northwesterly in a UE north of Taft (and approximately 1 mile north of U.S. 181) to FM 1074, east of Sinton.

- Routing then extends in a northwesterly direction, parallel to and approximately 1 mile north of SPRR to FM 881.

- Routing then crosses FM 881 and continues in a northwesterly direction to the WWTP.

<u>Odem</u>:

- From Taft's LS #3, the routing extends in a UE southward, parallel to FM 631, to approximately 7,500 feet southwest of US 181.
- Routing then turns westward for approximately 9,000 feet to FM 361.
- Routing continues westward in a UE, parallel to the roadway, and approximately 1 mile south of FM 1944 to the WWTP.

Property acquisition will be required for the following facilities:

- Regional WWTP
- Effluent or wastewater pump station at location where flows from Aransas Pass and Ingleside are combined.
- Intermediate wastewater pump station between Sinton and Taft.
- Intermediate wastewater pump station between Odem and Taft.

The regional WWTP site was estimated to require the purchase of approximately 50 acres of land. Pump station land requirements were estimated to be approximately 1/2 for each site.

6.0 INSTITUTIONAL AND ORGANIZATIONAL CONCEPTS FOR A REGIONAL WASTEWATER REUSE ENTITY

The usual entity to own and operate a regional wastewater collection, treatment, and disposal system is a conservation and reclamation district created pursuant to Article XVI Section 59, Texas Constitution.

6.1 Power and Authority Needed

The proposed special district will need the following powers:

- The power to have NPDES and state permits to receive wastewater from the cities, to treat the wastewater, and to transport the effluent by pipeline to Reynolds.
- The power to deliver effluent to the Northshore golf course for irrigation.
- The power to finance, construct, operate and maintain all facilities needed to exercise its purposes.
- The power to charge rates, or to receive payments from other sources, so as to finance its operations. Consideration must be given to whether the district will have the power to assess, level and collect taxes.
- The power to obtain, by eminent domain, or otherwise, sufficient land and all necessary easements, rights-of-way and leases for its facilities.

6.2 Organizational Structure

If a special district is created, it will be necessary to make several decisions, as follows:

- Creation. The SPMWD may be created by the legislature. In the alternative, a water control and improvement district or a municipal utility district can be created by the Texas Natural Resource Conservation Commission.

- <u>The SPMWD's Boundary</u>. The SPMWD's boundary is critical if the SPMWD's directors are to be elected, and if the SPMWD is to have the power to tax. Only people living within the district will be entitled to vote in elections to elect directors or to authorize taxes.

- <u>The SPMWD Directors</u>. The creating legislation will provide the number of directors, and whether the directors will be elected or appointed. If the directors are to be appointed, they can be appointed by the governor, the participating cities, the county commissioners court, or by a combination of various authorities. If the SPMWD is a WCID or MUD, it will have five directors, who must own land within the SPMWD, and who are elected for four year terms.

- <u>Financial Ability</u>. If the SPMWD is to have the power to tax, this power will have to be confirmed by the voters.

- <u>Organizational Structure</u>. The SPMWD will be governed by a Board of Directors. The SPMWD's functions will be performed by its general manager, its staff, and its consultants and contractees.

<u>Existing Districts</u>

San Patricio Municipal Water District is an existing district that provides treated water to several of the participating cities. The statute creating that SPMWD, and later amendatory statutes, do not contain express authority to handle wastewater. However, Sec. 17a of Art. 8280-145 provides that, within San Patricio County, the SPMWD shall have all of the powers and be governed by the provisions of the general laws governing water control and improvement districts. These laws are found in Chapter 51, Texas Water Code. Under certain circumstances, a WCID has the power to treat and dispose of domestic, industrial and other wastes. (Sec. 51.331, Texas Water Code).

The Regional Waste Disposal Act (the "Act") is found in Chapter 30, Texas Water Code. It gives certain powers to districts created under Article XVI, Sec. 59 of the Texas Constitution. The San Patricio Municipal Water District is such a district.

The Act authorizes districts to perform the functions contemplated in this report. It authorizes the SPMWD to contract with the cities to perform these functions, and the cities are authorized to pay for this service from their waterworks system, sewer system, or their combined water and sewer systems. The contracts can be an obligation against the taxing power of the cities if this is authorized by an election. The SPMWD may issue bonds secured by a pledge of all or part of the revenue from these contracts.

6.3 Operational Methods and Procedures

Several legal issues listed below will need to be considered further, when implementation of regional wastewater reuse project is considered. These issues are as follows:

- Will the SPMWD be require to obtain NPDES and state permits?
- Will the plant be a Publicly Owned Treatment System?
- Will anyone that has come to rely on the cities' discharge for their withdrawal of water from streams complain?
- Who holds the dam and reservoir permit for Green Lake? Will this permit have to be amended?
- Will the bonds of the SPMWD be tax exempt if Reynolds has an absolute obligation to take the effluent for a long period of years?

Answers to the questions listed above will determine what has to be done to resolve the issues and allow implementation of a project.

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7.0 RECOMMENDED PLAN

7.1 Regional Wastewater Effluent Reuse System

Based on the cost calculations of this study, Portland is the only city in the study area for which direct transfer of effluent from its present facilities to Reynolds Metals for reuse showed a benefit-cost ratio greater than 1.0, and, therefore, could be judged to be economically feasible (Section 2.5.3). Implementation of a Portland to Reynolds Metals effluent reuse project could increase the water supply available to the San Patricio Municipal Water District service area by approximately 1,400 acre-feet per year (based on projected effluent in the year 2000), which is about 10 percent of the quantity of water presently used in the SPMWD's service area, at a cost of $117 per acre-feet. Such a project has the potential to increase the water supply available from the Choke Canyon/Lake Corpus Christi system by about 608 acre-feet per year, which is the net effect taking into account releases that would be required for bays and estuaries. Therefore, if a regional wastewater reuse system, as described below in Section 7.2, is not implemented, it is recommended that Portland to Reynolds effluent reuse project be given further consideration for implementation if permitting, financing, and management arrangements can be made.

7.2 Regional Wastewater Treatment and Reuse System

Annual benefits to individual Northshore area cities to participate in a regional wastewater collection and treatment facility, with sales of reclaimed water to Reynolds Metals for reuse, include cost savings from upgrading and operating existing facilities plus the revenue from the sale of reclaimed water. The costs include debt service and operation and maintenance of facilities (pump stations and force mains) to move raw sewage to the regional treatment facility and a proportionate share of the debt service and operation and maintenance costs of the regional wastewater treatment plant. The benefits vary with price received for reclaimed water and costs of upgrading existing facilities. The costs vary with interest rates on capital required for both plant upgrade and new facilities and with distance that raw sewage must be transported. A benefit-cost analysis is presented for interest rates of five, six, seven and ten percent, assuming a reclaimed water price of $0.40 per thousand gallons (Tables 7-1 and 7-2). If costs equal benefits, the benefit-cost ratio is 1.0. If benefits exceed costs, then the benefit-cost ratio is greater than 1.0, and the higher the benefits for a given cost, the greater the benefit-cost ratio.

The analyses showed that a regional wastewater collection, treatment, and reuse facility may be feasible for Portland, Gregory, Aransas Pass, and Ingleside if interest rates on capital do not exceed six percent. Under the assumptions expressed above, the benefit-cost ratio for a Portland, Gregory, Aransas Pass, Ingleside facility would be greater than 1.0 for each of the cities if interest on capital is six percent or less (Table 7-2). For a Portland, Gregory, Aransas Pass, and Ingleside facility, the quantity of effluent that could be supplied to Reynolds Metals for reuse would be 2.89 mgd or 3,237 acre-feet per year, which is slightly more than the 2.8 mgd of untreated water that was used by Reynolds Metals in 1992 and 1993 (Section 2.4.1.2.3), and is about 23 percent of the quantity of water, presently used within the San Patricio Municipal Water District's service area. However, at the $0.40/1,000 gallons effluent price, if interest rates are seven percent, the benefit-cost ratio for Ingleside drops below 1.0 and for Aransas Pass drops to a range of 0.9 to 1.1 (Table 7-2).

In the cases of Taft, Sinton, and Odem, the costs exceeded the benefits, due largely to the greater costs for conveyance of raw sewage longer distances (Table 2-18). Thus, this study shows that a regional wastewater reuse facility with Portland, Gregory, Aransas Pass, Ingleside,

TABLE 7-1

REGIONAL WASTEWATER PRIMARY TREATMENT FACILITIES BENEFIT - COST RATIO

City Or Combination of Cities	Annual Benefit (In Thousands of Dollars)				Annual Cost (In Thousands of Dollars)					Benefit Cost Ratio
	Value of Effluent at $0.40 per 1,000	Cost Savings		Total Benefit	New Pump Station & Force Main		Regional WWTP		Total Cost	
		Plant Upgrade/ Maint.	Existing Plant O & M		Debt Service 8% interest	O & M	Debt Service 8% interest	O & M		
Portland	$183	$103	$269	$555	$170	$119	$166	$146	$601	0.9
Portland (Combined with Gregory)	$183	$103	$269	$555	$170	$119	$128	$112	$529	1.0
Gregory (Combined with Portland)	$35	$9	$102	$146	$55	$48	$38	$34	$175	0.8
Portland (Combined with Gregory, Aransas Pass & Ingleside)	$183	$103	$269	$555	$170	$119	$100	$86	$475	1.2
Gregory (combined with Portland, Aransas Pass & Ingleside)	$35	$9	$102	$146	$55	$48	$29	$25	$157	0.9
Aransas Pass (Combined with Portland, Gregory & Ingleside)	$136	$152	$269	$557	$272	$202	$73	$63	$610	0.9
Ingleside (Combined with Portland, Gregory & Aransas Pass)	$69	$18	$191	$278	$128	$99	$60	$52	$339	0.8
Total of Portland & Gregory Combined	$218	$112	$371	$701	$225	$167	$166	$146	$704	1.0
Total of Portland, Gregory, Aransas Pass & Ingleside Combined[1]	$423	$282	$831	$1,536	$625	$468	$262	$226	$1,581	1.0

[1]See Table 2-18; total quantity is 2.89 MGD or 3,237 acre-feet per year.

TABLE 7-2

REGIONAL WASTEWATER FACILITIES - PRIMARY TREATMENT
BENEFIT - COST SENSITIVITY ANALYSIS WITH VARYING INTEREST RATES

(In Thousands of Dollars)

City	Total Cost	Total Cost (Debt Service & O & M)			Benefit - Cost Ratio		
		@ 7%	@ 6%	@ 5%	@ 7%	@ 6%	@ 5%
Portland	$555	$522-584	$488-546	$448-502	0.9-1.0	1.0-1.1	1.1-1.2
Portland (Combined with Gregory)	$555	$459-514	$429-481	$394-442	1.1-1.2	1.2-1.3	1.3-1.4
Gregory (Combined with Portland)	$146	$153-170	$143-159	$131-146	0.9-1.0	0.9-1.0	1.0-1.1
Portland (Combined Aransas Pass)	$555	$452-507	$422-474	$388-435	1.1-1.2	1.2-1.3	1.3-1.4
Aransas Pass (Combined with Portland)	$557	$633-708	$592-662	$544-608	0.8-0.9	0.8-0.9	0.9-1.0
Portland (combined with Portland, Aransas Pass & Ingleside)	$555	$412-462	$385-432	$354-397	1.2-1.3	1.3-1.4	1.4-1.6
Gregory (combined with Portland, Aransas Pass & Ingleside)	$146	$137-153	$128-143	$118-131	1.0-1.1	1.0-1.1	1.1-1.2
Aransas Pass (Combined with Portland, Gregory & Ingleside)	$557	$530-592	$495-554	$455-509	0.9-1.1	1.0-1.1	1.1-1.2
Ingleside (Combined with Portland, Gregory & Aransas Pass)	$278	$294-329	$275-308	$253-283	0.8-0.9	0.9-1.0	1.0-1.1
Total of Portland & Gregory Combined	$701	$612-684	$572-640	$525-588	1.0-1.1	1.1-1.2	1.2-1.3
Total of Portland & Aransas Combined	$1112	$1085-1215	$1014-1136	$931-1044	0.9-1.0	1.0-1.1	1.1-1.2
Total of Portland, Gregory, Aransas Pass & Ingleside Combined	$1536	$1374-1536	$1284-1436	$1179-1319	1.0-1.1	1.1-1.2	1.2-1.3

and Reynolds Metals Company may be feasible if interest rates are in the five to six percent range (Table 7-2). The size of the regional wastewater treatment plant would need to be 5.0 mgd, and is recommended for further consideration toward permitting, financing, and management.

7.3 Green Lake Outfall System Improvements for Flood Protection

The improvements to the Green Lake outfall system include: (1) Spillway modifications; (2) Channel enlargements; and (3) Hydraulic improvements to railroad and highway structures that cross the Green Lake Channel. The spillway modifications needed are to drop the concrete sill (and top of risers) to elevation 18.0 feet-msl, remove much of the existing embankment and replace with a concrete ogee spillway with a crest elevation of 19.0 feet msl. The ogee spillway would have a crest length of 75 feet and would require the construction of new concrete retaining walls and an access bridge. The proposed modifications to the Green Lake Dam and Spillway Structure will lower the 100-year flood level in Green Lake from elevation 30.0 to 25.9 feet-msl. The estimated spillway reconstruction project capital cost is approximately $1.03 million, with an annual debt service of $105,000.

The proposed Phase I channel improvements include excavation to lower and widen the existing overbank areas to elevation 18.0 feet. A bottom width to elevation 18.0 that varies between approximately 175 feet to approximately 250 feet is proposed for the main portion of the channel. Maximum 4:1 side slopes are proposed in order to enhance the greenbelt area and provide for ease of maintenance. Proposed Phase I improvements for the upstream portion of the Green Lake Channel include excavation at a slope of 0.035 percent with a bottom width of 125 feet and 3:1 side slopes. A stabilized roadbed that parallels the channel is also recommended in Phase I to allow ease of access for routine maintenance and future Phase II improvements. The access road can be incorporated into the greenbelt design in order to provide maintenance of drainage and park facilities. It is anticipated that the majority of Phase I construction will be performed by the San Patricio County Drainage District (SPCDD). Total project capital cost of the Phase I channel improvements is estimated at $1.44 million for construction, with annual debt service of $146,000.

Construction costs for improvements to railroad and highway structures that cross the Green Lake channel are estimated at $2.23 million. By implementation of the Phase I improvements (spillway modifications, channel enlargement and alignments, and railroad and highway crossings), the existing 100-year water surface elevation in Gregory would be lowered by 1.9 feet, from approximately 33.1 feet-msl to approximately 31.2 feet-msl and would allow the channel to contain the 5-year flood.

Proposed Phase II improvements include excavating the main and upstream portions of the Green Lake Channel at a slope of 0.035 percent with a bottom width of 125 feet and 3:1 side slopes. Further development of the greenbelt area may be implemented during Phase II, as funds are available.

Phase II improvements will lower the calculated water surface elevation (CWSEL) in southwestern Gregory by approximately 1.9 feet, from the Phase I CWSEL at approximately 31.2 feet-msl to the Phase II CWSEL of approximately 29.3 feet-msl. In comparison to existing conditions, Phase II will reduce the CWSEL a total of 3.8 feet-msl, from the estimated existing conditions CWSEL of 33.1 feet-msl. A comparison of the computed water surface profiles for each of the conditions shows that Phase II improvements reduce the CWSEL for all flood frequencies analyzed (5-, 10- and 100-year). The 5-year and 10-year floods would be contained within the channel banks, however, the 100-year flood target water surface elevation of 28.0 feet-msl would not be completely contained within the ultimate Phase II channel improvements.

Phase II construction costs are estimated at $353,000, with an annual debt service of $36,000. These cost estimates are based on the assumption that excavation would be performed by the SPCDD, with spreading of disposal materials to adjacent land.

Estimated annual costs for Green Lake Channel and Spillway improvements and recommended railroad/highway structure improvements to protect against the 100-year flood event are $529,000 and would produce annual benefits estimated at $413,000, plus non-pecuniary water quality enhancements and recreational and ecological benefits. Although the benefit-cost ratio for the 100-year event is 0.8, when benefits from future development are included, improvements considered would fully protect the area in the case of the 5-year and 10-year flood events. Thus, additional consideration should be given to refinements of the analyses for potential implementation of those parts of the channel improvements and spillway modifications that provide the most protection.

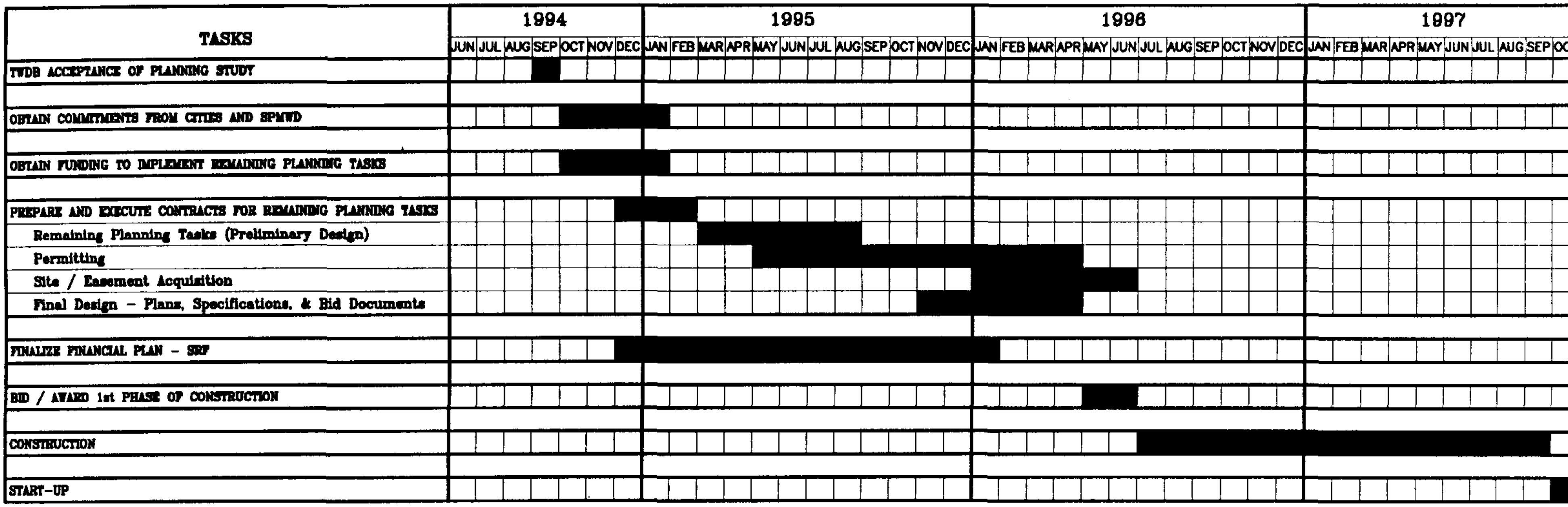
From Table 3-4, it is also seen that benefit-cost ratios for existing and future conditions are 1.0 and 1.4, respectively, when only costs attributed to the Northshore Project are considered.

7.4 Implementation Schedule

Figure 7-1 presents a preliminary implementation schedule for placing the first phase of a regional wastewater treatment and effluent reuse system into operation.

Tasks shown on the schedule are of a general nature and are intended to present one possible realistic schedule for implementation. Individual time lines will be revised, as required, for specific projects that are identified in the future. The initial regional system project is

NORTHSHORE PLANNING STUDY
REGIONAL WASTEWATER TREATMENT SYSTEM
IMPLEMENTATION SCHEDULE



NAISMITH ENGINEERING, INC.
ENGINEERING • ENVIRONMENTAL • SURVEYING
CORPUS CHRISTI, TEXAS

HDR ENGINEERING, INC.

MALCOLM PIRNIE

NORTHSHORE PLANNING STUDY
IMPLEMENTATION SCHEDULE

FIGURE 7–1

Drawn By: B.A.T.	Appr. By: G.A.B.	Scale: N.T.S.	Dwg. No.: 3745–S7	Sheet 1 of 1
Checked By: G.A.B.	Project No.: 3745	Date: 9/94	Rev.: 0	

estimated to require a minimum of 18 months for negotiating contracts, securing financing, and permitting. Preliminary/final design and site/easement acquisition tasks will be completed concurrent with the above. Bidding, award, construction and project start-up tasks are estimated to require an additional 18 months.

Based on the above, and assuming that the initial project begins in the fourth quarter of 1994, completion will occur in late 1997.

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APPENDIX A

REFERENCES

APPENDIX A
REFERENCES

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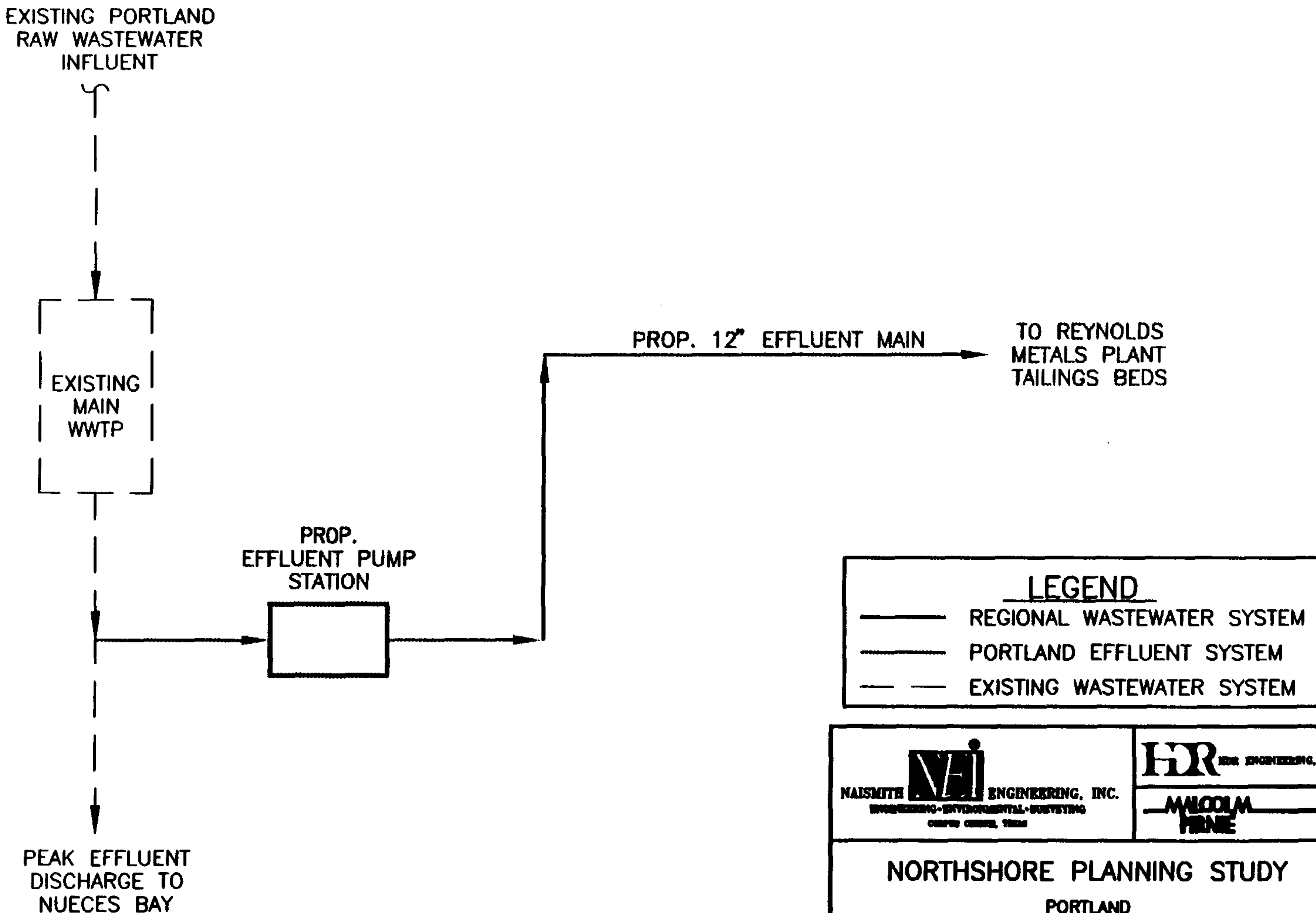
APPENDIX B

SCHEMATICS
ROUTING MAPS
AND
COST TABLES
FOR
WASTEWATER EFFLUENT
REUSE ALTERNATIVES



NAISMITH ENGINEERING, INC.

HDR ENGINEERING, INC.

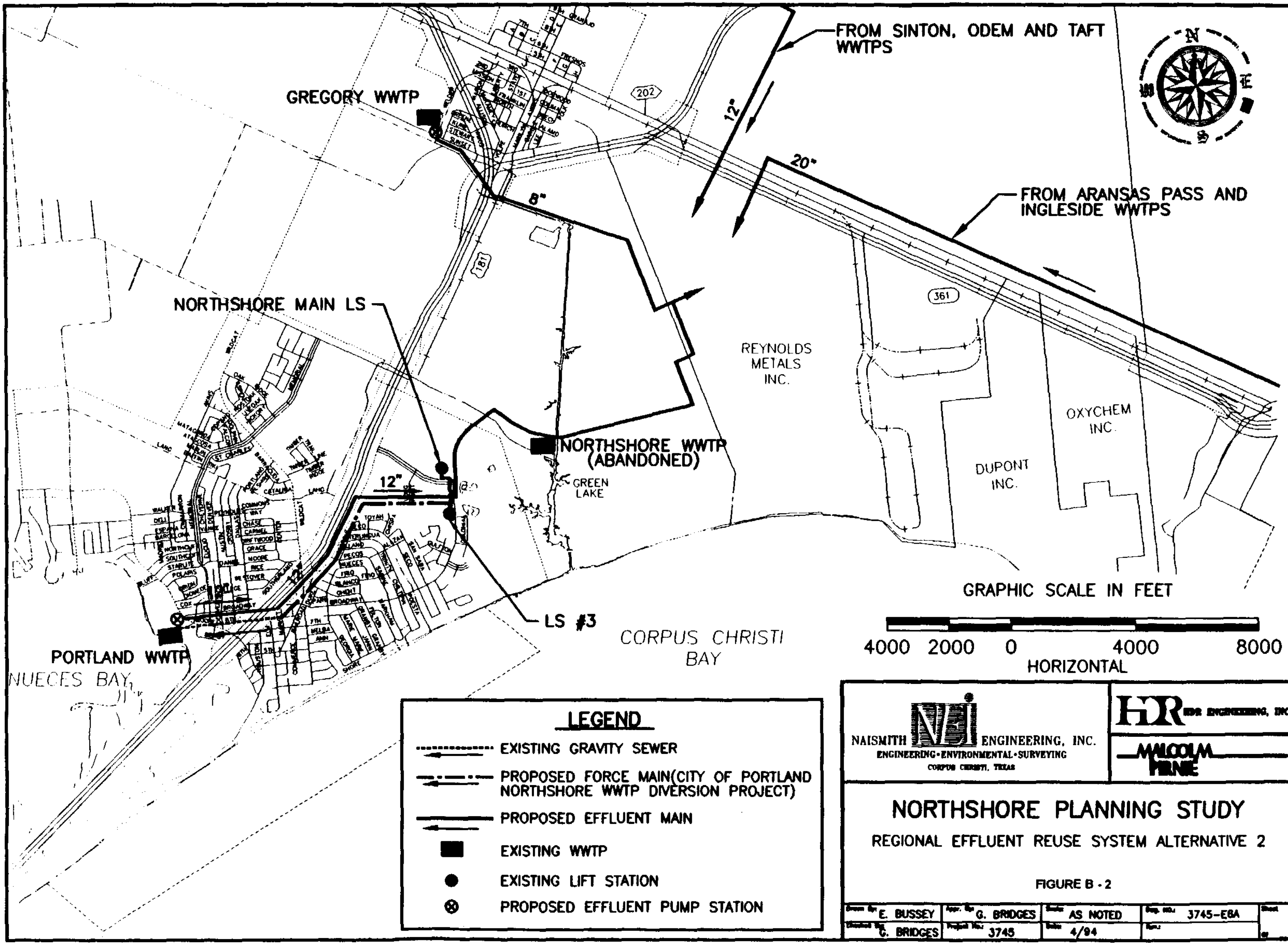
MALCOLM PIRNIE

NORTHSHORE PLANNING STUDY

PORTLAND
EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 1

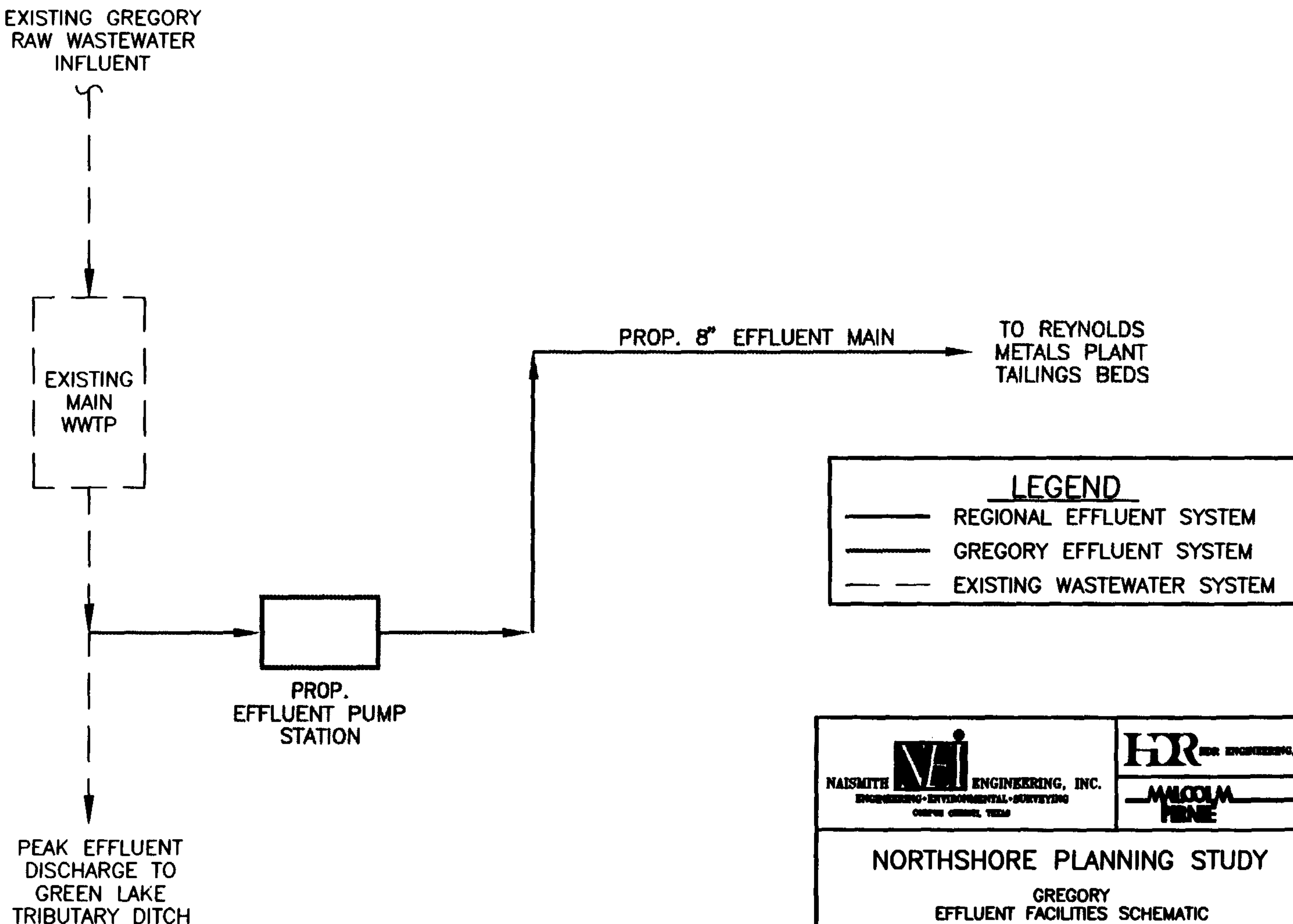
E. BUSSEY	G. BRIDGES	NONE	3745SCH8	
G. BRIDGES	3745	3/94		


FROM SINTON, ODEM AND TAFT WWTPS
GREGORY WWTP
202
12"
20"
8"
FROM ARANSAS PASS AND INGLESIDE WWTPS
181
361
NORTHSHORE MAIN LS
REYNOLDS METALS INC.
OXYCHEM INC.
NORTHSHORE WWTP (ABANDONED)
GREEN LAKE
DUPONT INC.
12"
GRAPHIC SCALE IN FEET
4000 2000 0 4000 8000
HORIZONTAL
LS #3
CORPUS CHRISTI BAY
PORTLAND WWTP
NUECES BAY
LEGEND
EXISTING GRAVITY SEWER
PROPOSED FORCE MAIN(CITY OF PORTLAND NORTHSHORE WWTP DIVERSION PROJECT)
PROPOSED EFFLUENT MAIN
EXISTING WWTP
EXISTING LIFT STATION
PROPOSED EFFLUENT PUMP STATION
NAISMITH ENGINEERING, INC.
ENGINEERING·ENVIRONMENTAL·SURVEYING
CORPUS CHRISTI, TEXAS
HDR ENGINEERING, INC.
MALCOLM PIRNIE
NORTHSHORE PLANNING STUDY
REGIONAL EFFLUENT REUSE SYSTEM ALTERNATIVE 2
FIGURE B - 2
E. BUSSEY
G. BRIDGES
AS NOTED
3745-E8A
G. BRIDGES
3745
4/94

APPENDIX B - TABLE 1
COST ESTIMATE
PORTLAND EFFLUENT AND RAW WASTEWATER FACILITIES
PHASED REGIONAL SYSTEM ALTERNATIVES

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
	PHASE I - EFFLUENT SYSTEM				
1.	16" PVC effluent main/force main	LF	17,500	$20	$350,000
2.	16" PVC effluent main/force main	LF	7,500	$35	$263,000
3.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
4.	Highway bore, 24" casing (Hwy. 181)	LF	200	$350	$70,000
5.	Railroad bore, 24" casing (SPRR)	LF	100	$350	$35,000
6.	Ditch crossing for 12" PVC	LS	1	$50,000	$50,000
		Sub-Total			$918,000
		Contingency (20%)			$184,000
		TOTAL ESTIMATED CONSTRUCTION COST			$1,102,000
		Professional Services (15%)			$165,000
		Easement/ROW Acquisition			$20,000
		TOTAL PROJECT CAPITAL COST			**$1,287,000**
		ANNUAL COSTS - PHASE I			
		Debt Service Sub-Total			$131,000
		Operations & Maintenance			$12,000
		Power			$23,000
		Sub-Total			$35,000
		TOTAL ANNUAL COST - PHASE I			**$166,000**

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
	PHASE II - WASTEWATER TREATMENT SYSTEM				
1.	Wastewater pump station at Main Plant	LS	1	$200,000	$200,000
2.	Flow equalization/storage facilities at Main Plant	LS	1	$125,000	$125,000
3.	Existing collection system pump station modifications	LS	1	$20,000	$20,000
4.	Odor control facilities	LS	1	$80,000	$80,000
		Sub-Total			$425,000
		Contingency (20%)			$85,000
		TOTAL ESTIMATED CONSTRUCTION COST			$510,000
		Professional Services (17%)			$87,000
		TOTAL PROJECT CAPITAL COST			**$597,000**
		ANNUAL COSTS - PHASE II			
		Debt Service Sub-Total (includes Phase I & II debt service)			$192,000
		Operations & Maintenance			$26,000
		Power			$23,000
		Chemical Addition			$70,000
		Sub-Total			$119,000
		TOTAL ANNUAL COST - PHASE II			**$311,000**



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NORTHSHORE PLANNING STUDY

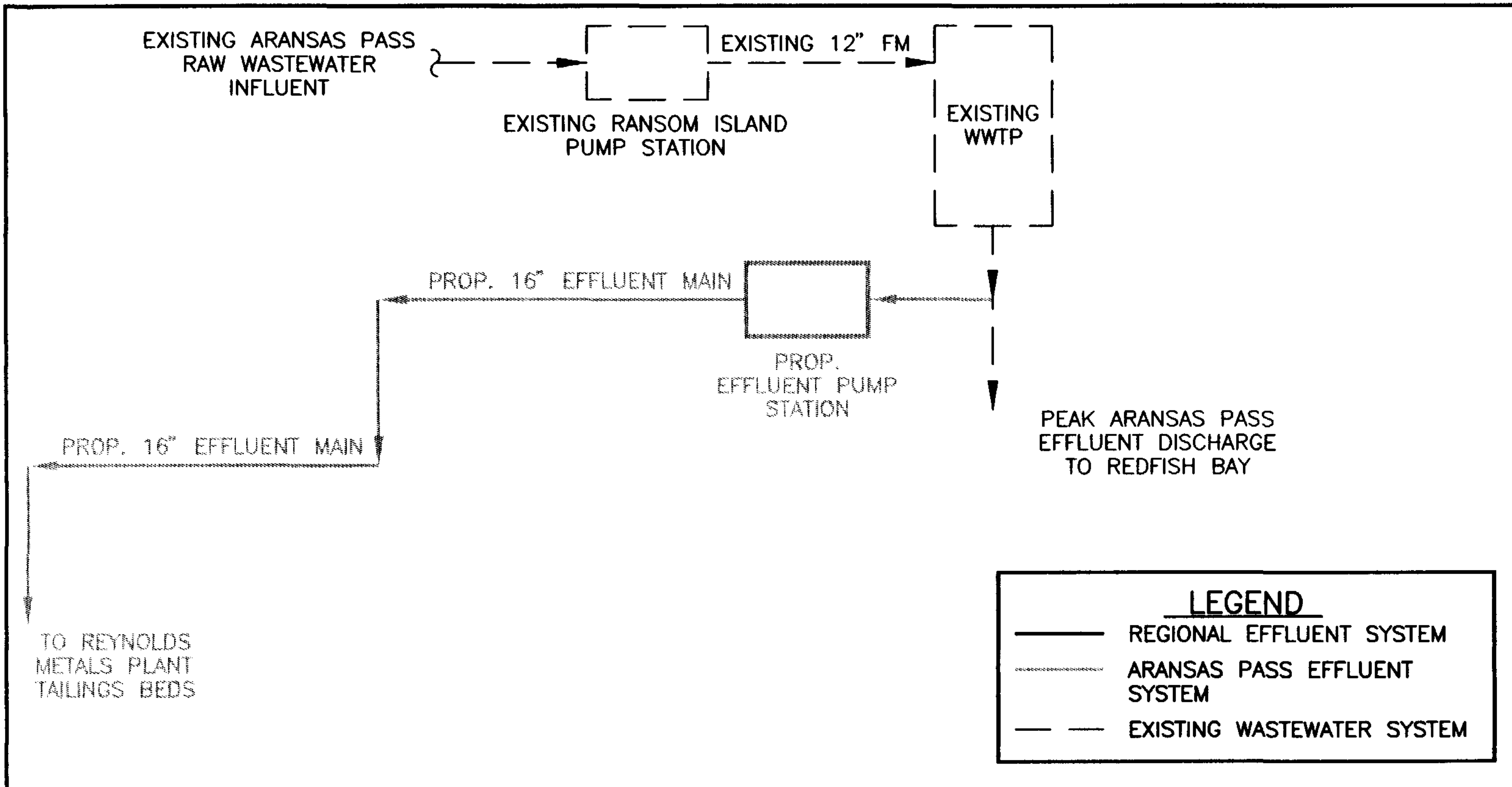
GREGORY EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 3

E. BUSSEY	G. BRIDGES	NONE	3745SC10	
G. BRIDGES	3745	3/94		

APPENDIX B - TABLE 2
COST ESTIMATE
GREGORY EFFLUENT FACILITIES
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	8" PVC effluent main	LF	9,300	$11	$102,000
2.	Effluent pump station at WWTP	LS	1	$75,000	$75,000
3.	Highway bore, 16" casing (Hwy. 181)	LF	200	$300	$60,000
4.	Railroad bore, 16" casing (SPRR)	LF	100	$300	$30,000
		Sub-Total			$267,000
		Contingency (20%)			$53,000
		TOTAL ESTIMATED CONSTRUCTION COST			$320,000
		Professional Services (18%)			$58,000
		Easement/ROW Acquisition			$10,000
		TOTAL PROJECT CAPITAL COST			**$388,000**
		ANNUAL COSTS			
		Debt Service Sub-Total			$40,000
		Operations & Maintenance			$12,000
		Power			$7,000
		Sub-Total			$19,000
		TOTAL ANNUAL COST			**$59,000**



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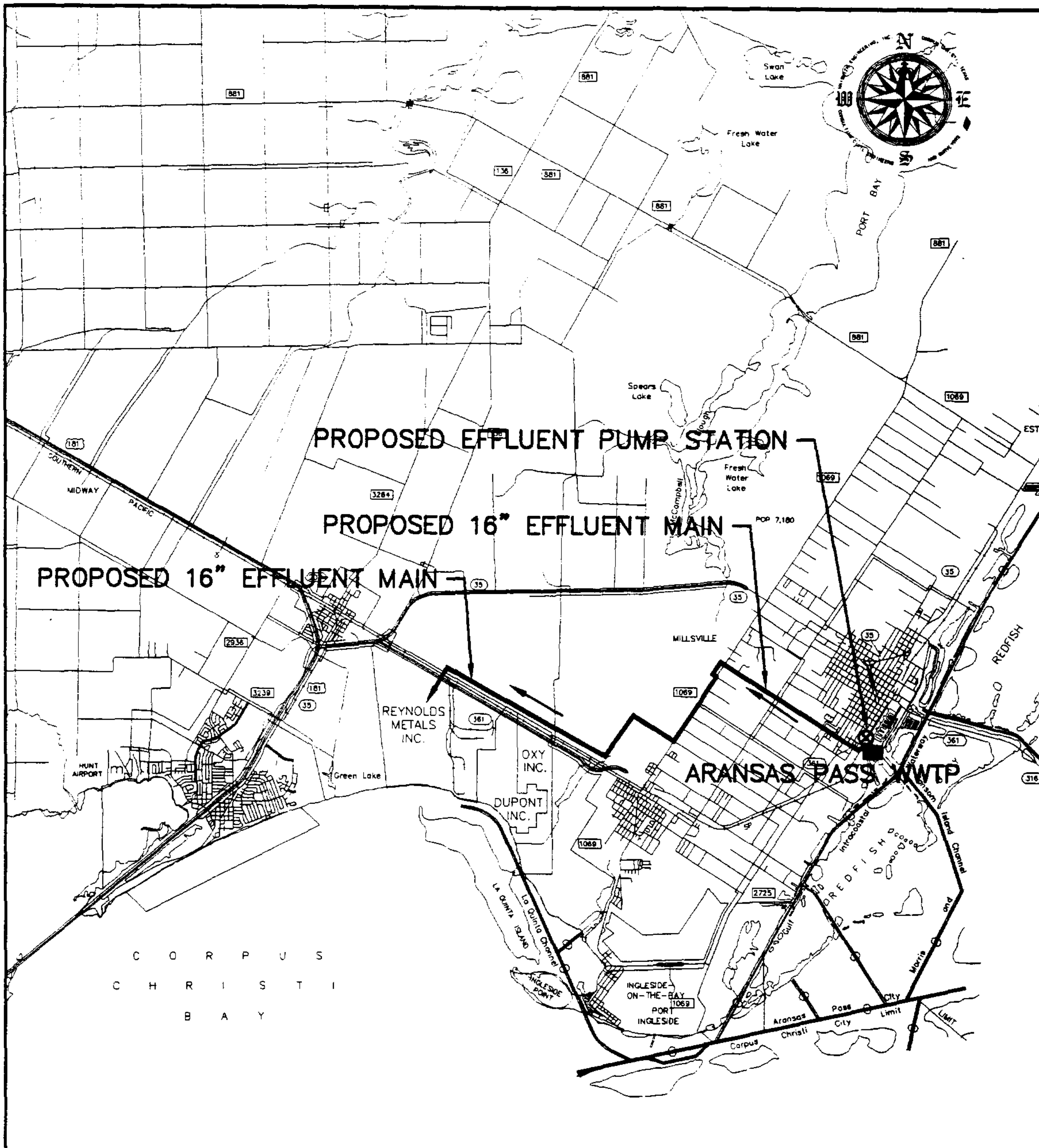
ARANSAS PASS
EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 4

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: NONE	Dwg. NO.: 3745SC15	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of



GRAPHIC SCALE IN FEET

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ARANSAS PASS EFFLUENT MAIN ROUTING

FIGURE B - 5

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-EM4	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:	of

APPENDIX B - TABLE 3
COST ESTIMATE
ARANSAS PASS EFFLUENT FACILITIES
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC effluent main	LF	49,400	$20	$988,000
2.	16" PVC effluent main	LF	6,800	$35	$238,000
3.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
4.	Highway bore, 24" casing (Hwy. 181)	LF	200	$350	$70,000
5.	Railroad bore, 24" casing (SPRR)	LF	250	$350	$88,000
6.	Highway bore, 24" casing (Hwy. 1069)	LF	60	$350	$21,000
7.	Highway bore, 24" casing (Hwy. 361)	LF	120	$350	$42,000
		Sub-Total			$1,597,000
		Contingency (20%)			$319,000
		TOTAL ESTIMATED CONSTRUCTION COST			$1,916,000
		Professional Services (14%)			$268,000
		Easement/ROW Acquisition			$60,000
		TOTAL PROJECT CAPITAL COST			**$2,244,000**
		ANNUAL COSTS			
		Debt Service Sub-Total			$229,000
		Operations & Maintenance			$12,000
		Power			$27,000
		Sub-Total			$39,000
		TOTAL ANNUAL COST			**$268,000**

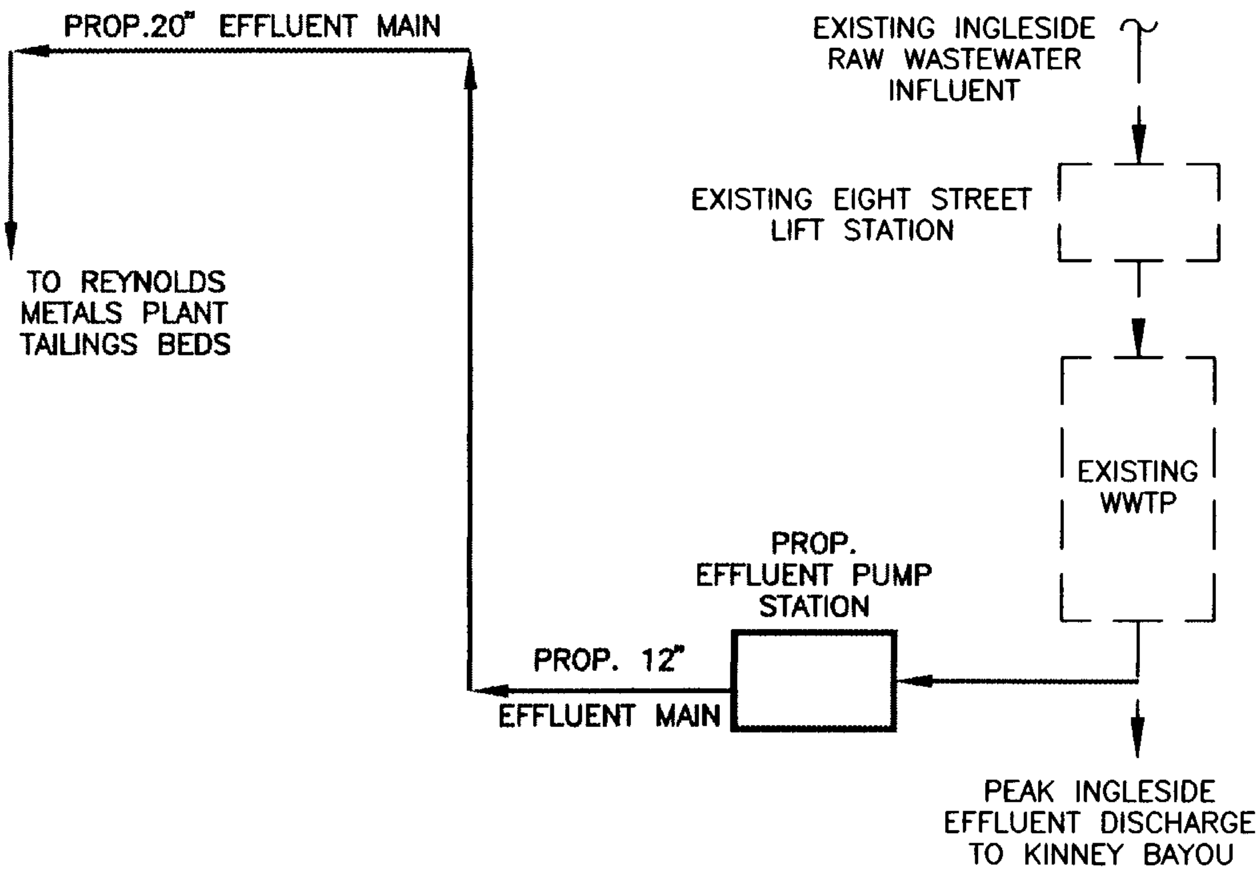
APPENDIX B - TABLE 4
COST ESTIMATE
ARANSAS PASS EFFLUENT FACILITIES (COMBINED WITH INGLESIDE)
REGIONAL EFFLUENT REUSE ALTERNATIVE

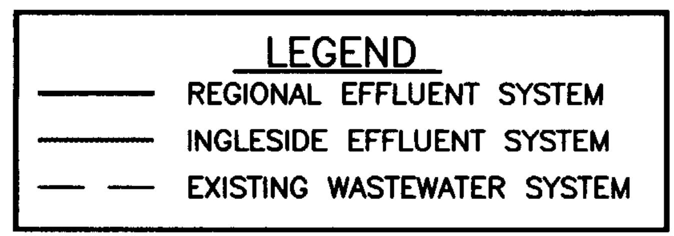
Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC effluent main	LF	28,100	$20	$562,000
2.	16" PVC effluent main	LF	6,800	$35	$238,000
3.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
4.	Railroad bore, 24" casing (Hwy. SPRR)	LF	100	$350	$35,000
5.	Highway bore, 24" casing (Hwy. 1069)	LF	60	$350	$21,000
6.	Highway bore, 24" casing (Hwy. 361)	LF	120	$350	$42,000
7.	20" PVC effluent main	LF	21,300	$30 (66%)	$422,000
8.	Highway bore, 28" casing (Hwy. 181)	LF	200	$400 (66%)	$53,000
9.	Railroad bore, 28" casing (SPRR)	LF	150	$400 (66%)	$40,000

Sub-Total	$1,563,000
Contingency (20%)	$313,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,876,000
Professional Services (14%)	$263,000
Easement/ROW Acquisition	$42,000
TOTAL PROJECT CAPITAL COST	**$2,181,000**

ANNUAL COSTS

Debt Service Sub-Total	$222,000
Operations & Maintenance	$12,000
Power	$27,000
Sub-Total	$39,000
TOTAL ANNUAL COST	**$261,000**





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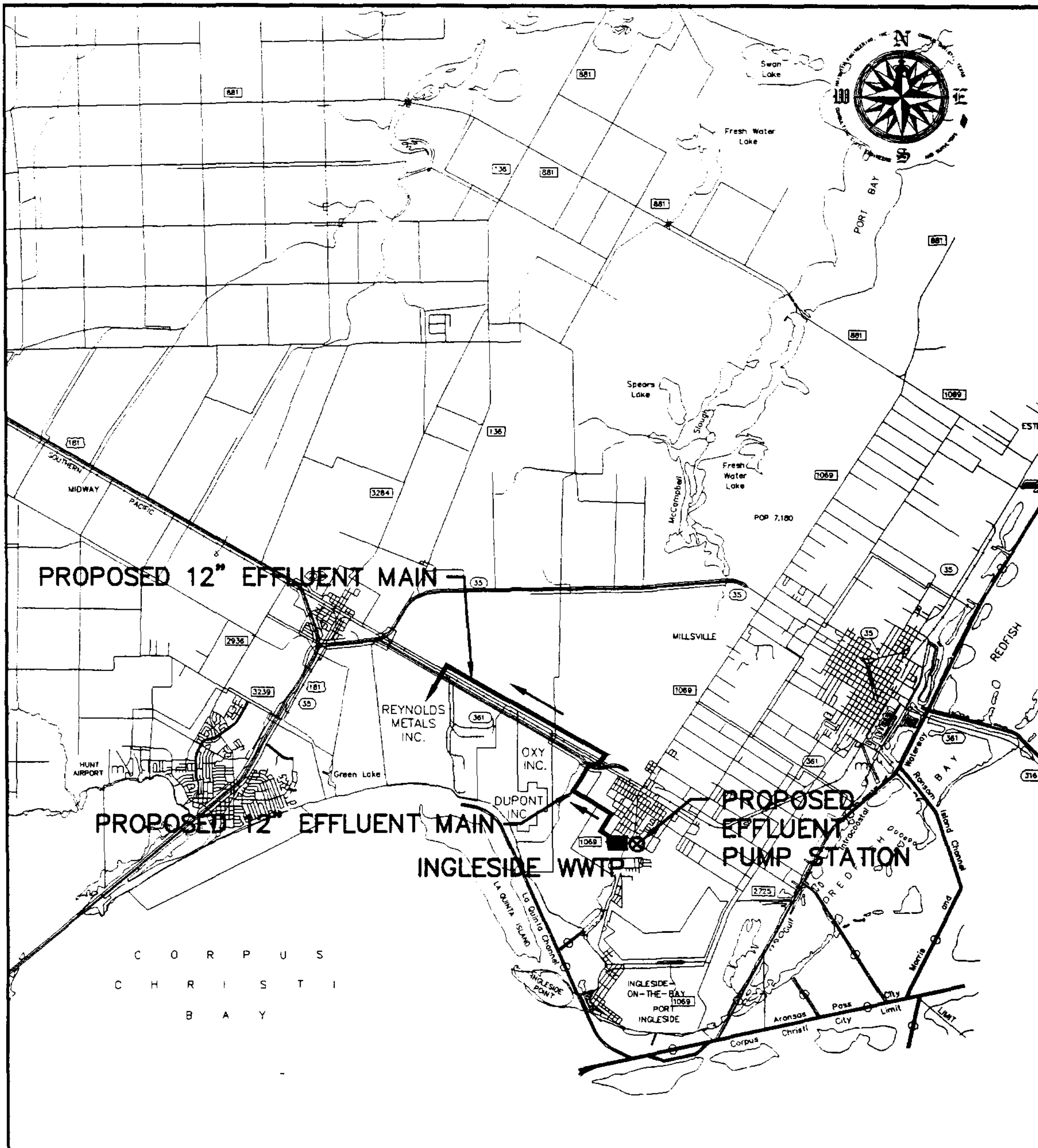
INGLESIDE EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 6

Drawn By: E. BUSSEY	App. By: G. BRIDGES	Scale: NONE	Dwg. No.: 3745SC16	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of



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INGLESIDE EFFLUENT MAIN ROUTING

FIGURE B - 7

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-EM5	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 4/94	Rev.:	of

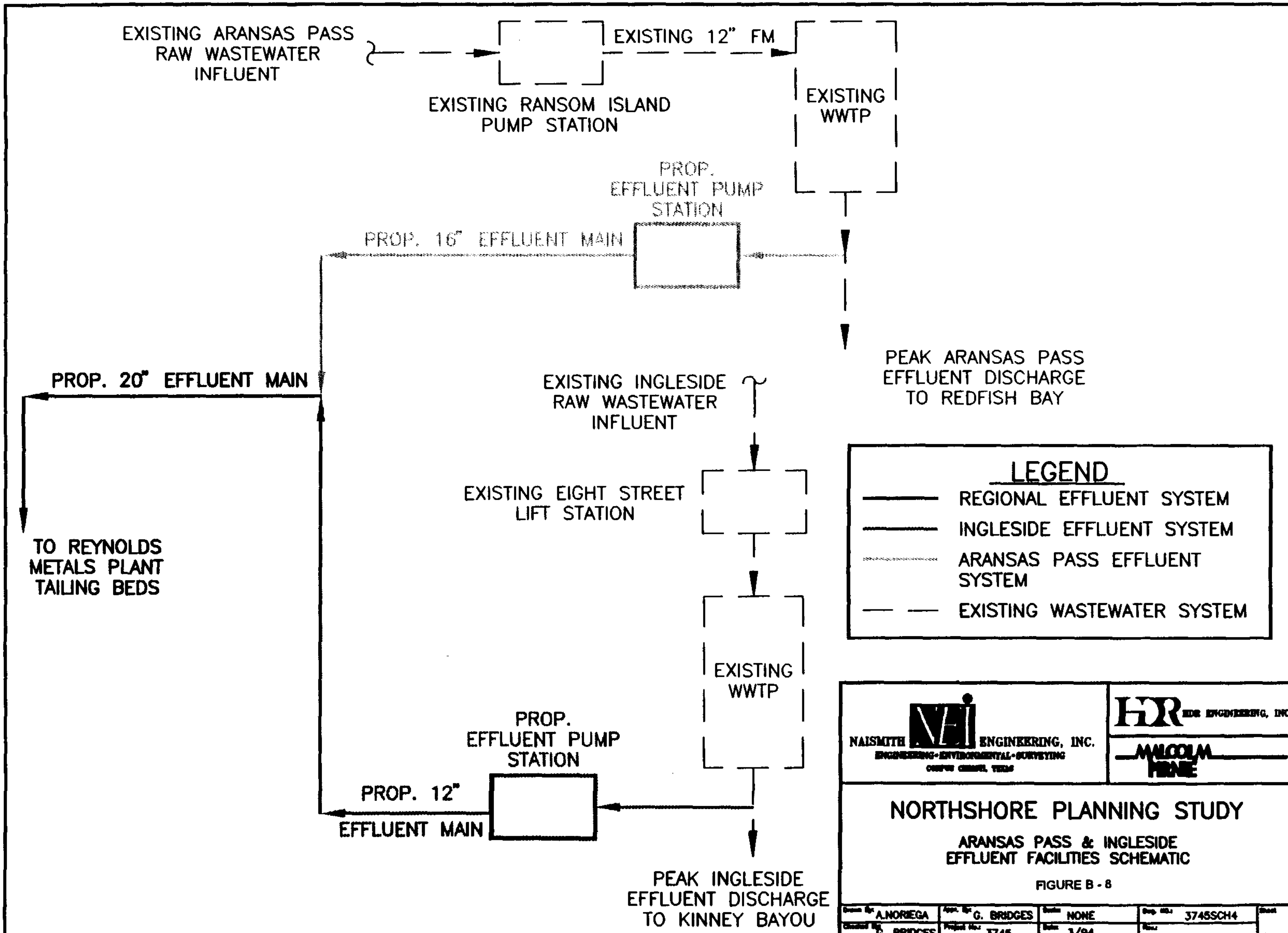
APPENDIX B - TABLE 5
COST ESTIMATE
INGLESIDE EFFLUENT FACILITIES
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC effluent main	LF	30,700	$15	$461,000
2.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
3.	Highway bore, 20" casing (Hwy. 181)	LF	400	$300	$120,000
4.	Railroad bore, 20" casing (SPRR)	LF	300	$300	$90,000

Sub-Total	$821,000
Contingency (20%)	$164,000
TOTAL ESTIMATED CONSTRUCTION COST	$985,000
Professional Services (15%)	$148,000
Easement/ROW Acquisition	$30,000
TOTAL PROJECT CAPITAL COST	**$1,163,000**

ANNUAL COSTS

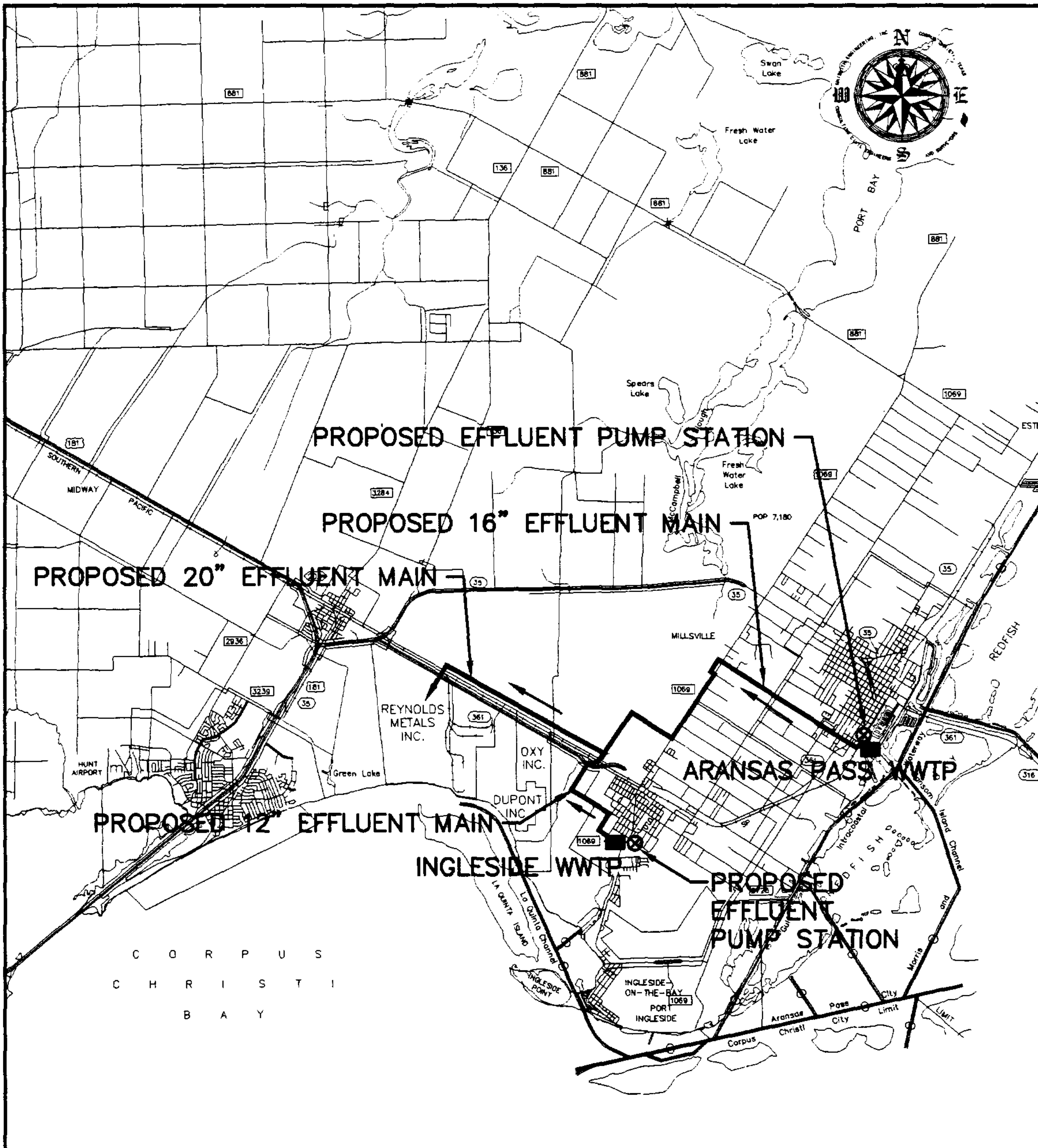
Debt Service Sub-Total	$119,000
Operations & Maintenance	$12,000
Power	21,000
Sub-Total	$33,000
TOTAL ANNUAL COST	**$152,000**



NORTHSHORE PLANNING STUDY

ARANSAS PASS & INGLESIDE EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 8



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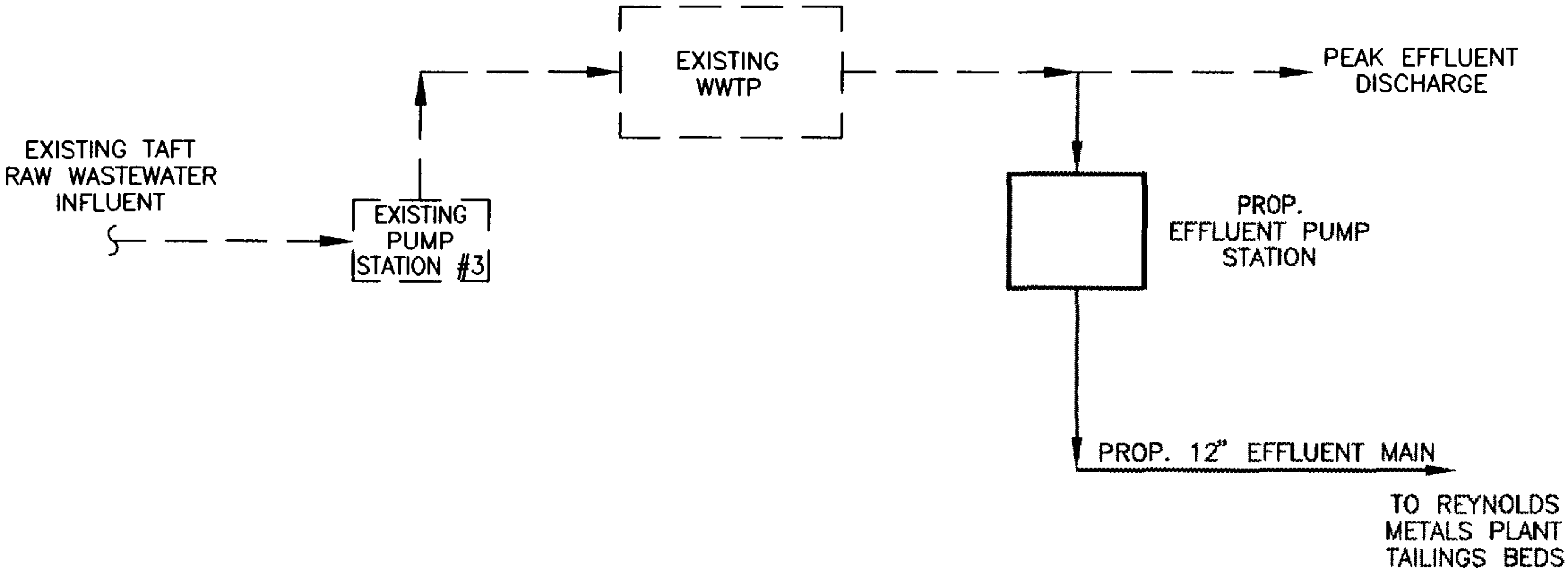
ARANSAS PASS & INGLESIDE EFFLUENT MAIN ROUTING

FIGURE B - 9

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.: 3745-EM1	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

APPENDIX B - TABLE 6
COST ESTIMATE
INGLESIDE EFFLUENT FACILITIES (COMBINED WITH ARANSAS PASS)
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC effluent main	LF	9,400	$15	$141,000
2.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
3.	Highway bore, 20" casing (Hwy. 181)	LF	400	$300	$120,000
4.	Railroad bore, 20" casing (SPRR)	LF	300	$300	$90,000
5.	20" PVC effluent main	LF	21,300	$30 (34%)	$217,000
6.	Highway bore, 28" casing (Hwy. 181)	LF	200	$400 (34%)	$27,000
7.	Railroad bore, 28" casing (SPRR)	LF	150	$400 (34%)	$20,000
		Sub-Total			$765,000
		Contingency (20%)			$153,000
		TOTAL ESTIMATED CONSTRUCTION COST			$918,000
		Professional Services (15%)			$138,000
		Easement/ROW Acquisition			$20,000
		TOTAL PROJECT CAPITAL COST			**$1,076,000**
		ANNUAL COSTS			
		Debt Service Sub-Total			$110,000
		Operations & Maintenance			$12,000
		Power			$17,000
		Sub-Total			$29,000
		TOTAL ANNUAL COST			**$139,000**



LEGEND

- REGIONAL WASTEWATER SYSTEM
- TAFT EFFLUENT SYSTEM
- EXISTING WASTEWATER SYSTEM

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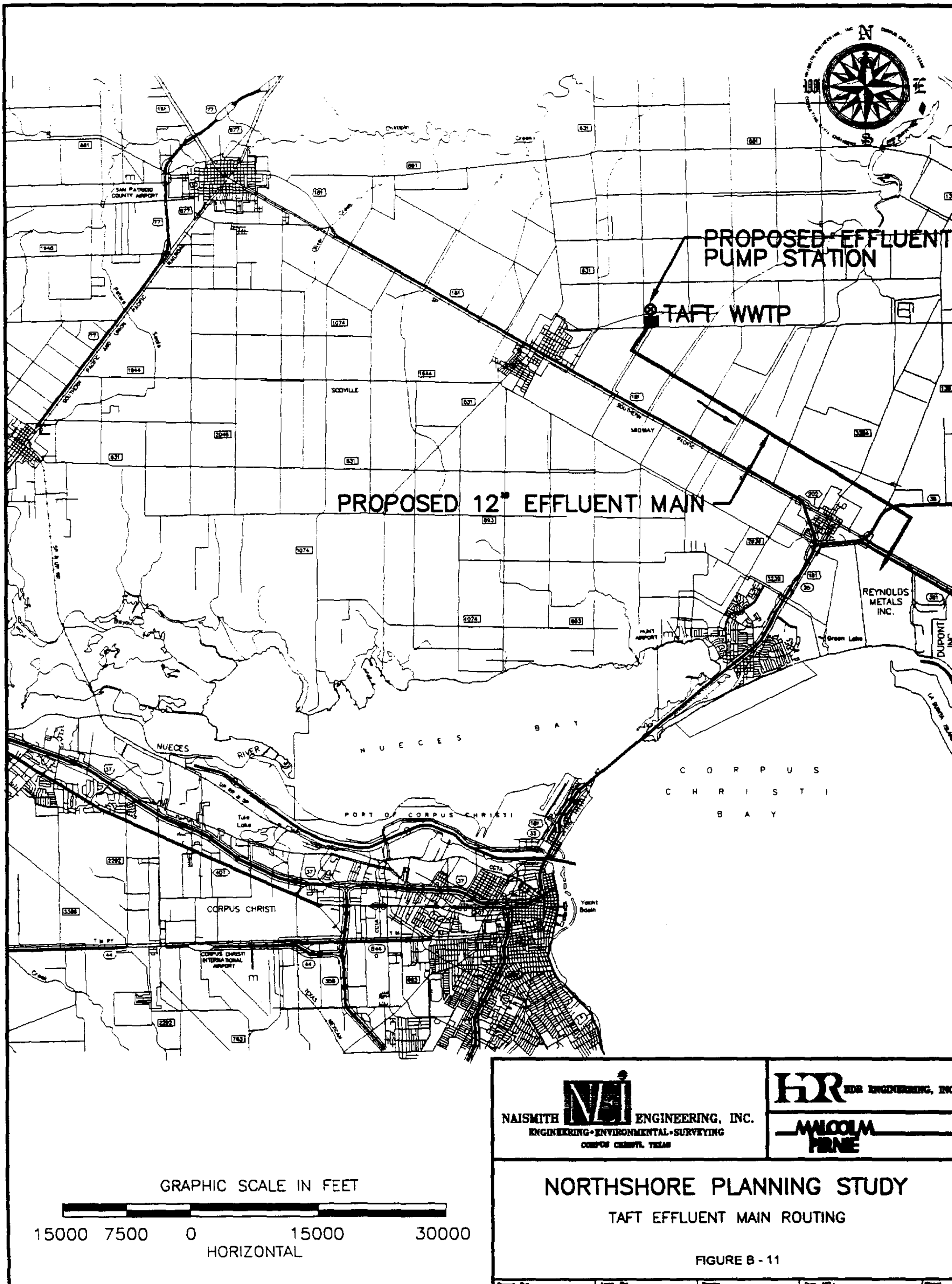
TAFT
EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 10

E. BUSSEY	G. BRIDGES	NONE	3745SC12
G. BRIDGES	3745	3/94	



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TAFT EFFLUENT MAIN ROUTING

FIGURE B - 11

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-EM6	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 4/94	Rev.:	of

APPENDIX B - TABLE 7
COST ESTIMATE
TAFT EFFLUENT FACILITIES
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC effluent main	LF	45,700	$15	$686,000
2.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
3.	Highway bore, 20" casing (Hwy. 181)	LF	200	$250	$50,000
4.	Railroad bore, 20" casing (SPRR)	LF	150	$250	$38,000
5.	Highway bore, 20" casing (Hwy. 136)	LF	100	$250	$25,000
6.	Highway bore, 20" casing (Hwy. 35)	LF	100	$250	$25,000

Sub-Total	$974,000
Contingency (20%)	$195,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,169,000
Professional Services (15%)	$175,000
Easement/ROW Acquisition	$50,000
TOTAL PROJECT CAPITAL COST	**$1,394,000**

ANNUAL COSTS

Debt Service Sub-Total	$142,000
Operations & Maintenance	$12,000
Power	$7,000
Sub-Total	$19,000
TOTAL ANNUAL COST	**$161,000**

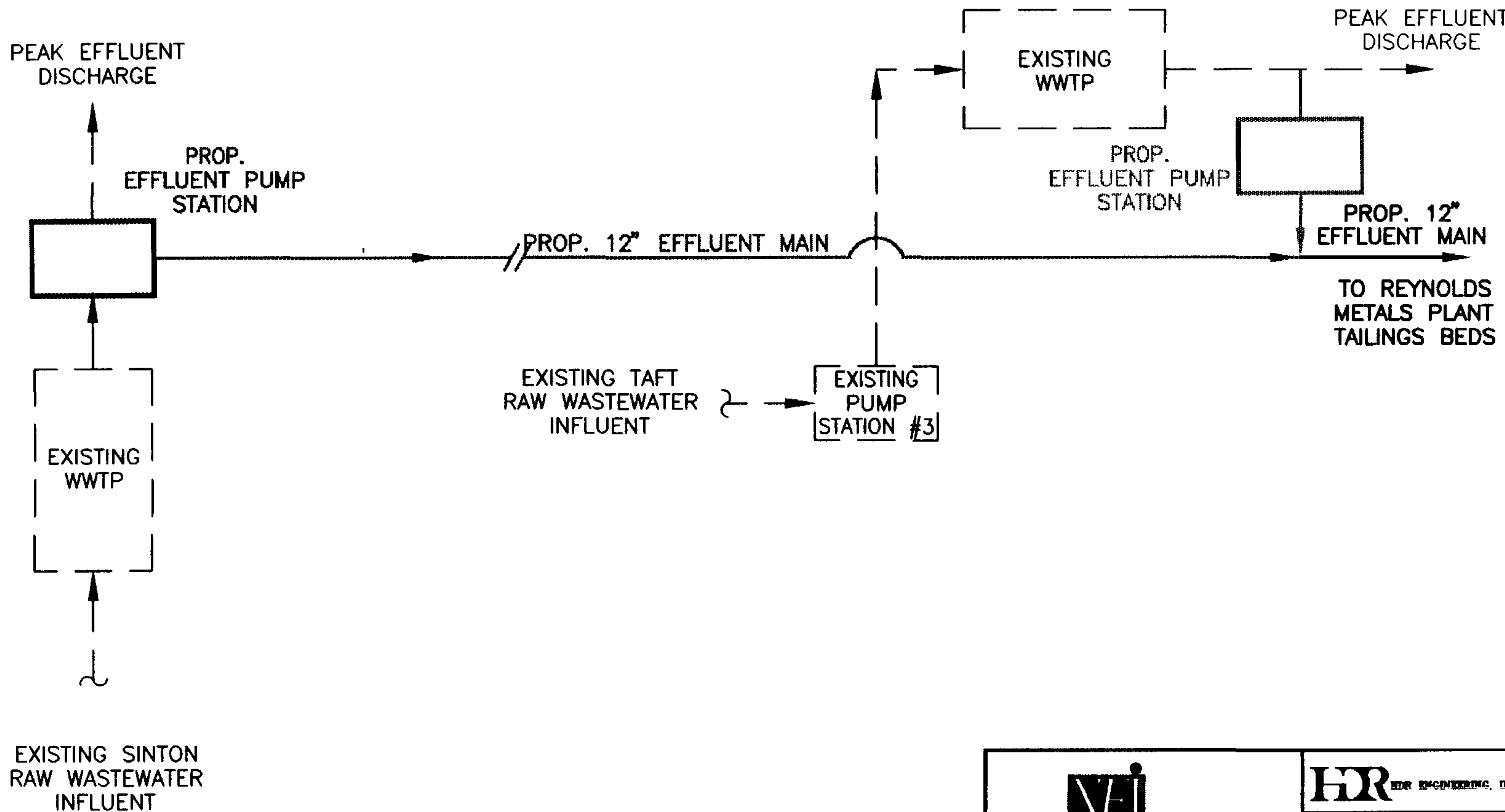
APPENDIX B - TABLE 8
COST ESTIMATE
TAFT EFFLUENT FACILITIES (COMBINED WITH SINTON)
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC effluent main	LF	4,100	$15	$62,000
2.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
3.	12" PVC effluent main	LF	41,600	$15 (50%)	$312,000
4.	Highway bore, 20" casing (Hwy. 181)	LF	200	$250 (50%)	$25,000
5.	Railroad bore, 20" casing (SPRR)	LF	150	$250 (50%)	$19,000

Sub-Total	$568,000
Contingency (20%)	$114,000
TOTAL ESTIMATED CONSTRUCTION COST	$682,000
Professional Services (16%)	$109,000
Easement/ROW Acquisition	$25,000
TOTAL PROJECT CAPITAL COST	**$816,000**

ANNUAL COSTS

Debt Service Sub-Total	$83,000
Operations & Maintenance	$12,000
Power	$10,000
Sub-Total	$22,000
TOTAL ANNUAL COST	**$105,000**



LEGEND

- REGIONAL EFFLUENT SYSTEM
- SINTON EFFLUENT SYSTEM
- TAFT EFFLUENT SYSTEM
- EXISTING WASTEWATER SYSTEM

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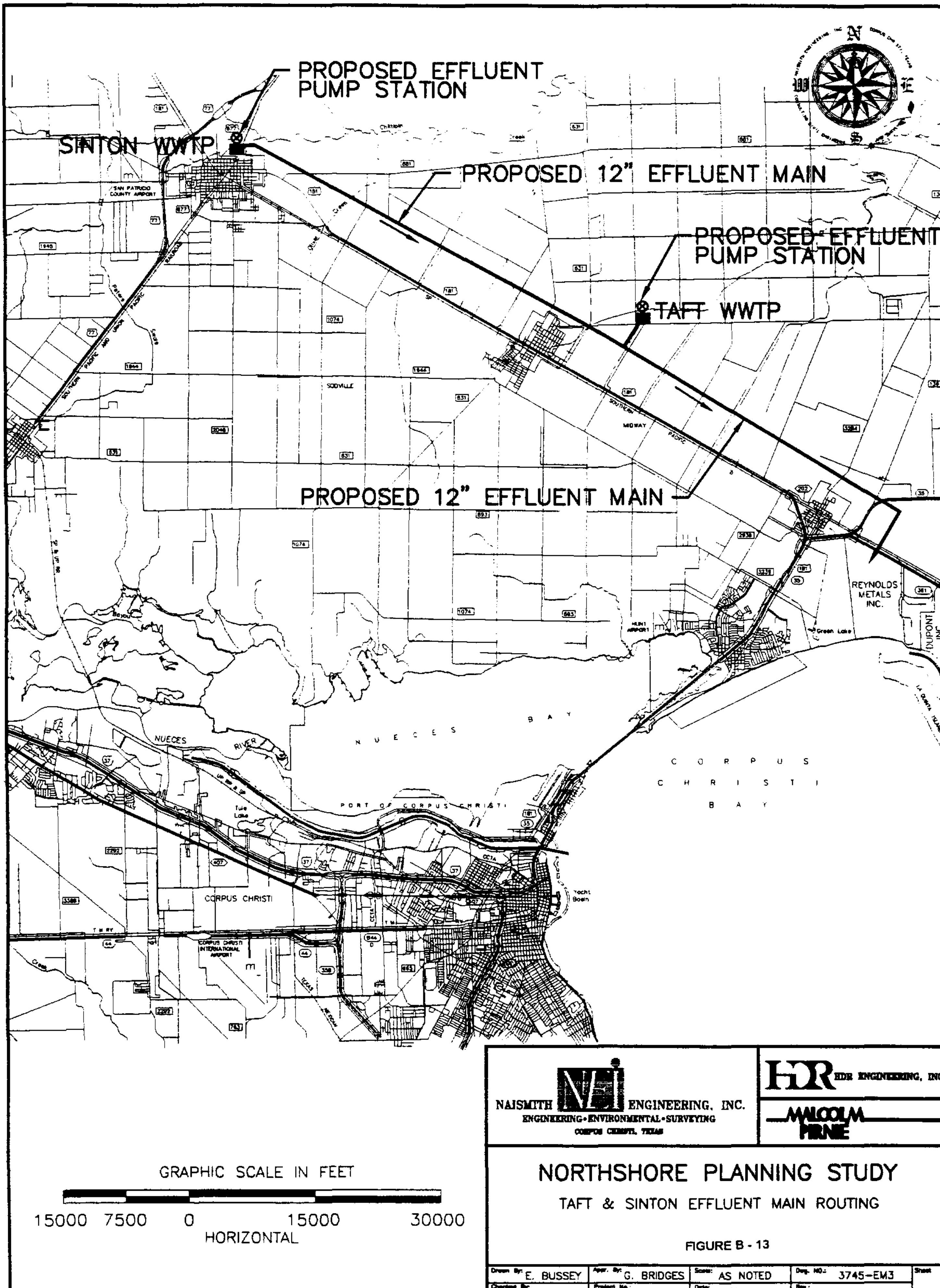
TAFT & SINTON EFFLUENT FACILITIES SCHEMATIC

FIGURE B - 12

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: NONE	Dwg. No.: 3745SC14	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of



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TAFT & SINTON EFFLUENT MAIN ROUTING

FIGURE B - 13

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-EM3	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

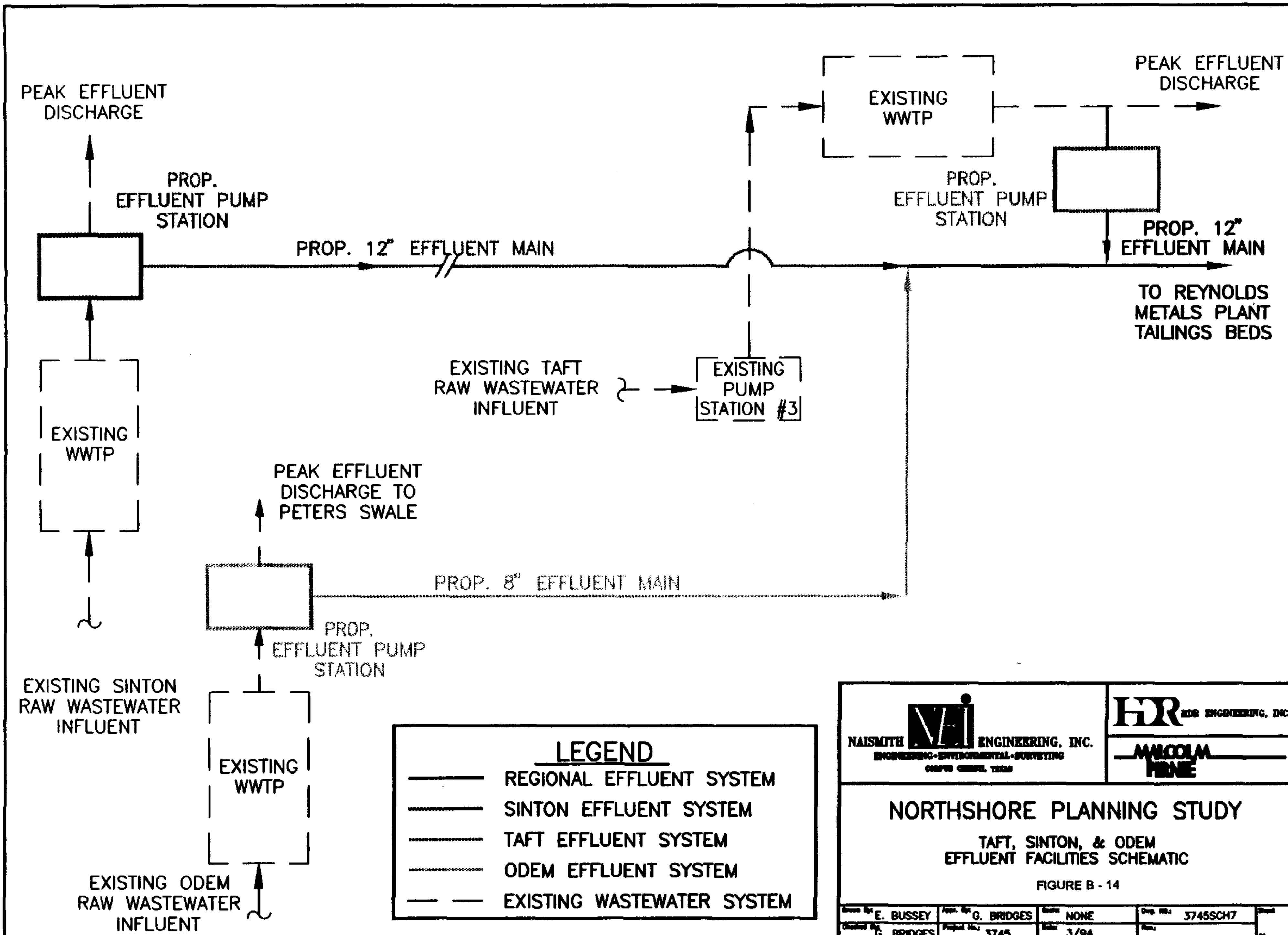
APPENDIX B - TABLE 9
COST ESTIMATE
SINTON EFFLUENT FACILITIES (COMBINED WITH TAFT)
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC effluent main	LF	50,800	$15	$762,000
2.	Effluent pump station at WWTP	LS	1	$150,000	$150,000
3.	Highway bore, 20" casing (Hwy. 881)	LF	120	$300	$36,000
4.	Highway bore, 20" casing (Hwy. 631)	LF	120	$300	$36,000
5.	12" PVC effluent main	LF	41,600	$15 (50%)	$312,000
6.	Highway bore, 20" casing (Hwy. 181)	LF	200	$250 (50%)	$25,000
7.	Railroad bore, 20" casing (SPRR)	LF	150	$250 (50%)	$19,000

Sub-Total	$1,340,000
Contingency (20%)	$268,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,608,000
Professional Services (15%)	$241,000
Easement/ROW Acquisition	$70,000
TOTAL PROJECT CAPITAL COST	**$1,919,000**

ANNUAL COSTS

Debt Service Sub-Total	$196,000
Operations & Maintenance	$12,000
Power	$13,000
Sub-Total	$25,000
TOTAL ANNUAL COST	**$221,000**


PEAK EFFLUENT DISCHARGE
PROP. EFFLUENT PUMP STATION
PROP. 12" EFFLUENT MAIN
EXISTING WWTP
EXISTING SINTON RAW WASTEWATER INFLUENT
PEAK EFFLUENT DISCHARGE TO PETERS SWALE
PROP. 8" EFFLUENT MAIN
PROP. EFFLUENT PUMP STATION
EXISTING WWTP
EXISTING ODEM RAW WASTEWATER INFLUENT
EXISTING TAFT RAW WASTEWATER INFLUENT
EXISTING PUMP STATION #3
EXISTING WWTP
PEAK EFFLUENT DISCHARGE
PROP. EFFLUENT PUMP STATION
PROP. 12" EFFLUENT MAIN
TO REYNOLDS METALS PLANT TAILINGS BEDS
LEGEND
REGIONAL EFFLUENT SYSTEM
SINTON EFFLUENT SYSTEM
TAFT EFFLUENT SYSTEM
ODEM EFFLUENT SYSTEM
EXISTING WASTEWATER SYSTEM
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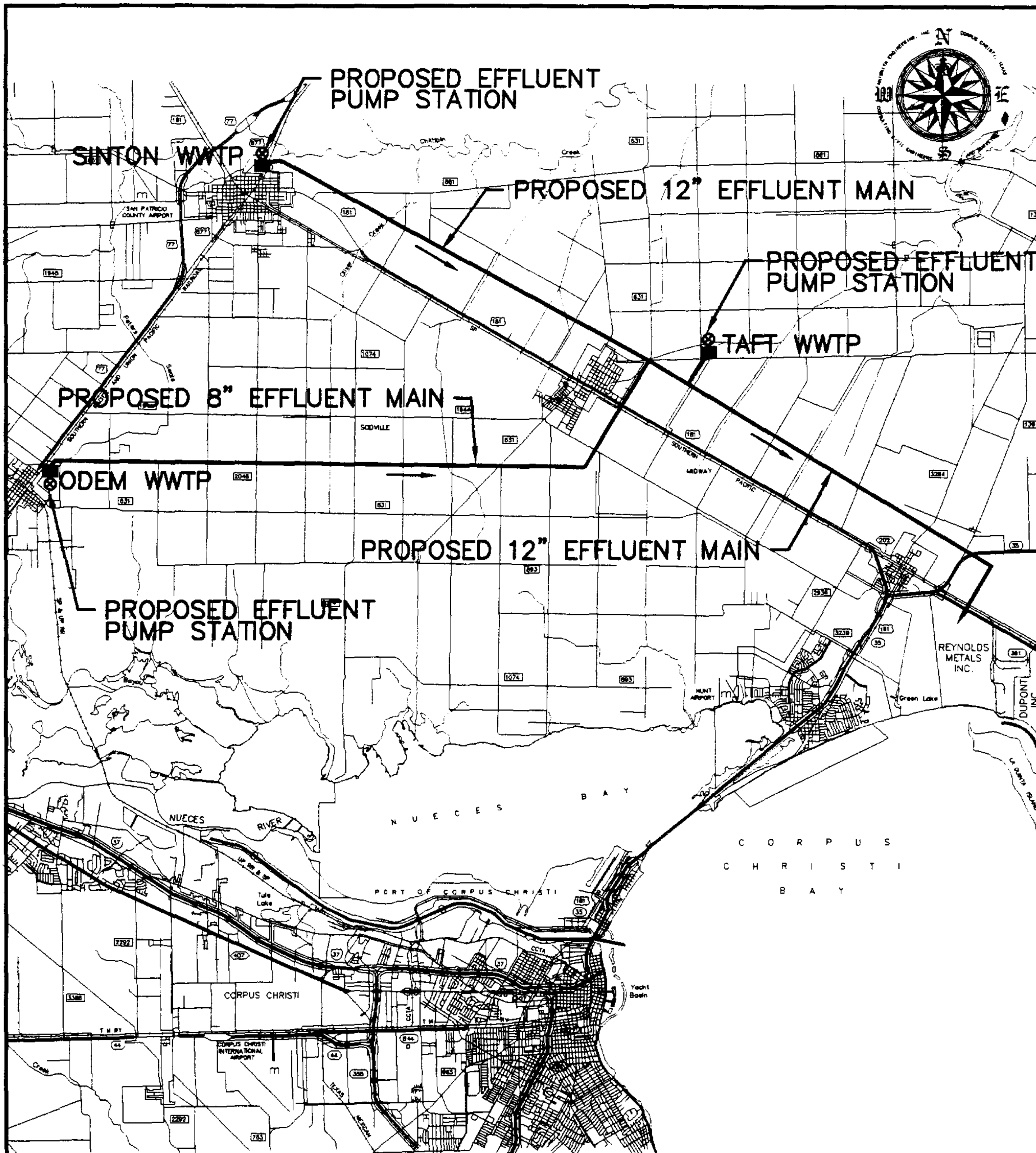
MALCOLM PIRNIE
NORTHSHORE PLANNING STUDY
TAFT, SINTON, & ODEM EFFLUENT FACILITIES SCHEMATIC
FIGURE B - 14
E. BUSSEY
G. BRIDGES
NONE
3745SCH7
G. BRIDGES
3745
3/94



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TAFT, SINTON, & ODEM EFFLUENT MAIN ROUTING

FIGURE B - 15

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-EM2	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	Of

APPENDIX B - TABLE 10
COST ESTIMATE
ODEM EFFLUENT FACILITIES (COMBINED WITH SINTON & TAFT)
REGIONAL EFFLUENT REUSE ALTERNATIVE

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	8" PVC effluent effluent main	LF	70,000	$11	$770,000
2.	Effluent pump station at WWTP	LS	1	$120,000	$120,000
3.	Peters Swale crossing				
4.	Highway bore, 16" casing (Hwy. 2046, 1074, 631, 893, 181)	LF	440	$300	$132,000
5.	Railroad bore, 16" casing (SPRR)	LF	100	$300	$30,000
6.	12" PVC effluent main	LF	45,600	$15 (10%)	$68,000
7.	Highway bore, 20" casing (Hwy. 181)	LF	200	$250 (10%)	$5,000
8.	Railroad bore, 20" casing (SPRR)	LF	150	$250 (10%)	$4,000

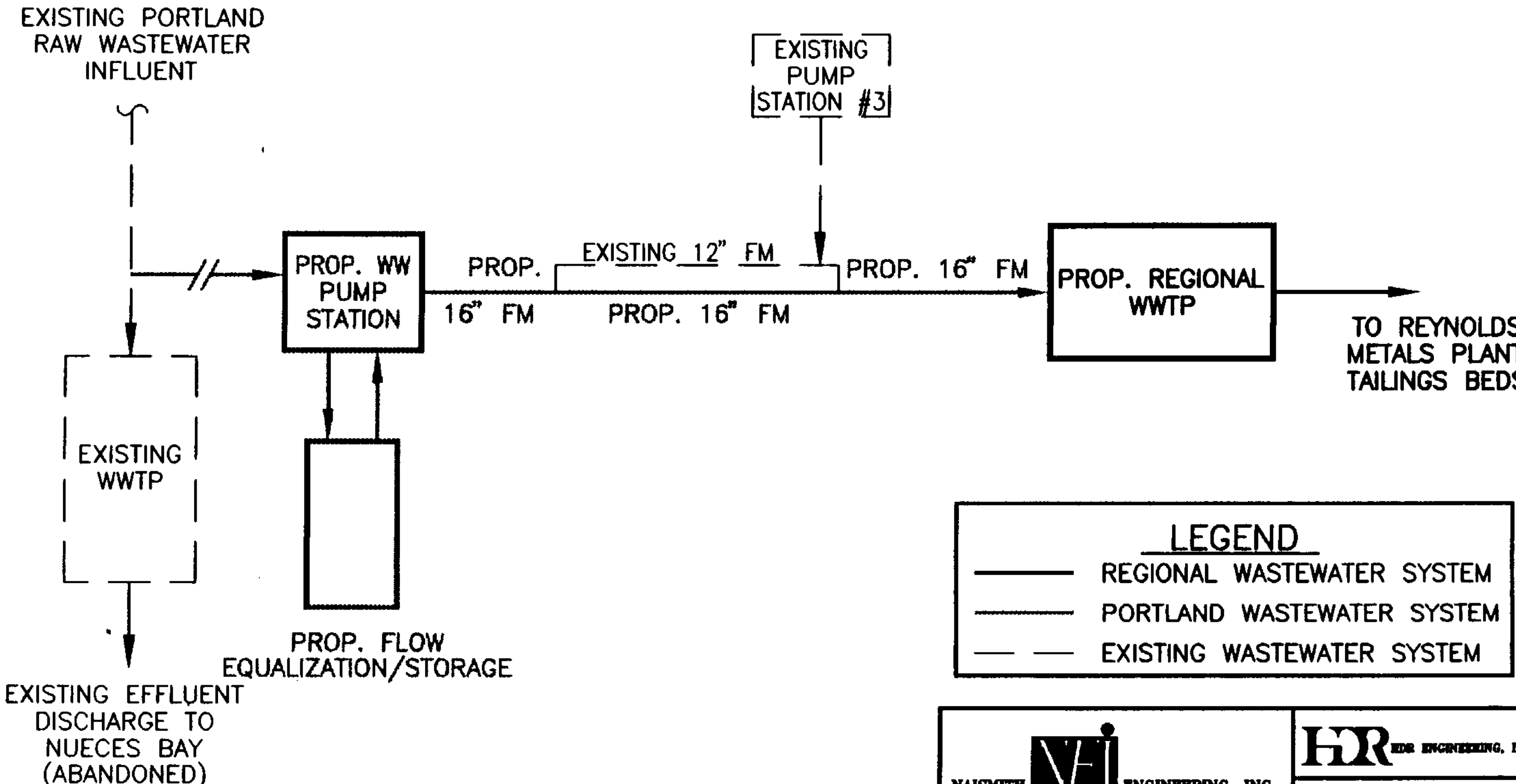
Sub-Total	$1,129,000
Contingency (20%)	$226,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,355,000
Professional Services (14%)	$190,000
Easement/ROW Acquisition	$75,000
TOTAL PROJECT CAPITAL COST	**$1,620,000**
ANNUAL COSTS	
Debt Service Sub-Total	$165,000
Operations & Maintenance	$12,000
Power	$10,000
Sub-Total	$22,000
TOTAL ANNUAL COST	**$187,000**

APPENDIX C

SCHEMATICS
ROUTING MAPS
AND
COST TABLES
FOR

REGIONAL WASTEWATER
TREATMENT PLANT
ALTERNATIVES

OPTIONS 1 AND 2



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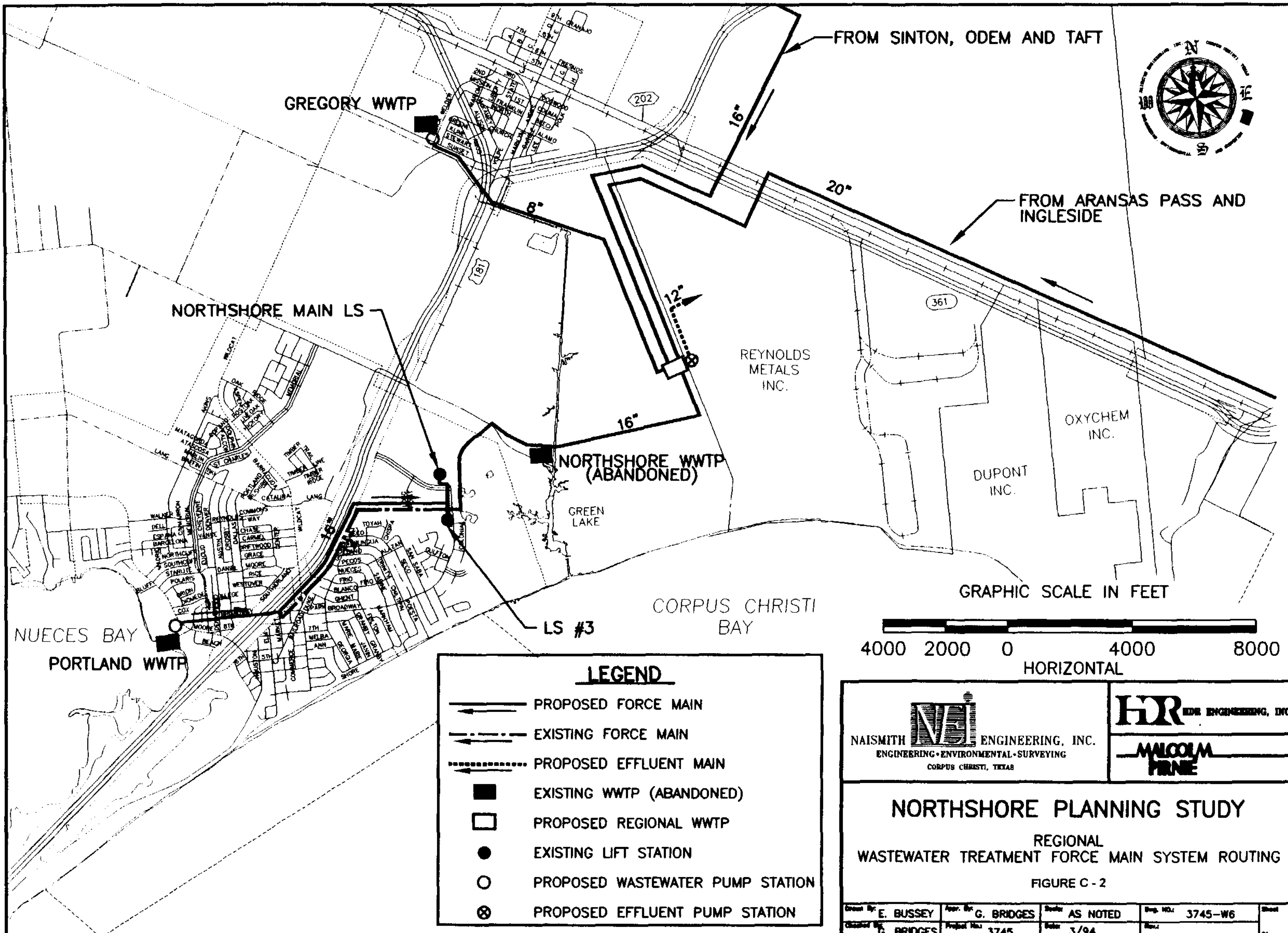
MALCOLM PIRNIE

NORTHSHORE PLANNING STUDY

PORTLAND WASTEWATER FACILITIES SCHEMATIC

FIGURE C -1

A. NORIEGA	G. BRIDGES	NONE	3745SCH5	
G. BRIDGES	3745	3/94		


FROM SINTON, ODEM AND TAFT
GREGORY WWTP
16"
202
20"
FROM ARANSAS PASS AND INGLESIDE
8"
181
12"
361
NORTHSHORE MAIN LS
REYNOLDS METALS INC.
16"
OXYCHEM INC.
NORTHSHORE WWTP (ABANDONED)
DUPONT INC.
GREEN LAKE
16"
GRAPHIC SCALE IN FEET
CORPUS CHRISTI BAY
LS #3
NUECES BAY
4000 2000 0 4000 8000
HORIZONTAL
PORTLAND WWTP
LEGEND
PROPOSED FORCE MAIN
EXISTING FORCE MAIN
PROPOSED EFFLUENT MAIN
EXISTING WWTP (ABANDONED)
PROPOSED REGIONAL WWTP
EXISTING LIFT STATION
PROPOSED WASTEWATER PUMP STATION
PROPOSED EFFLUENT PUMP STATION
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CORPUS CHRISTI, TEXAS
HDR ENGINEERING, INC.
MALCOLM PIRNIE
NORTHSHORE PLANNING STUDY
REGIONAL
WASTEWATER TREATMENT FORCE MAIN SYSTEM ROUTING
FIGURE C - 2
E. BUSSEY
G. BRIDGES
AS NOTED
3745-W6
G. BRIDGES
3745
3/94

APPENDIX C - TABLE 1
COST ESTIMATE
PORTLAND RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	17,500	$20	$350,000
2.	16" PVC force main	LF	7,500	$35	$263,000
3.	Wastewater pump station at Main Plant	LS	1	$200,000	$200,000
4.	Flow equalization/storage facilities at Main Plant	LS	1	$125,000	$125,000
5.	Existing collection system pump station modifications	LS	1	$20,000	$20,000
6.	Highway bore, 24" casing (Hwy. 181)	LF	200	$350	$70,000
7.	Railroad bore, 24" casing (SPRR)	LF	100	$350	$35,000
8.	Ditch crossing for 16" PVC	LS	1	$50,000	$50,000
9.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$1,193,000
Contingency (20%)	$239,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,432,000
Professional Services (15%)	$215,000
Easement/ROW Acquisition	$20,000
TOTAL PROJECT CAPITAL COST	**$1,667,000**

ANNUAL COSTS

Debt Service Sub-Total	$170,000
Operations & Maintenance	$26,000
Power	$23,000
Chemical Addition	$70,000
Sub-Total	$119,000
TOTAL ANNUAL COST	**$289,000**

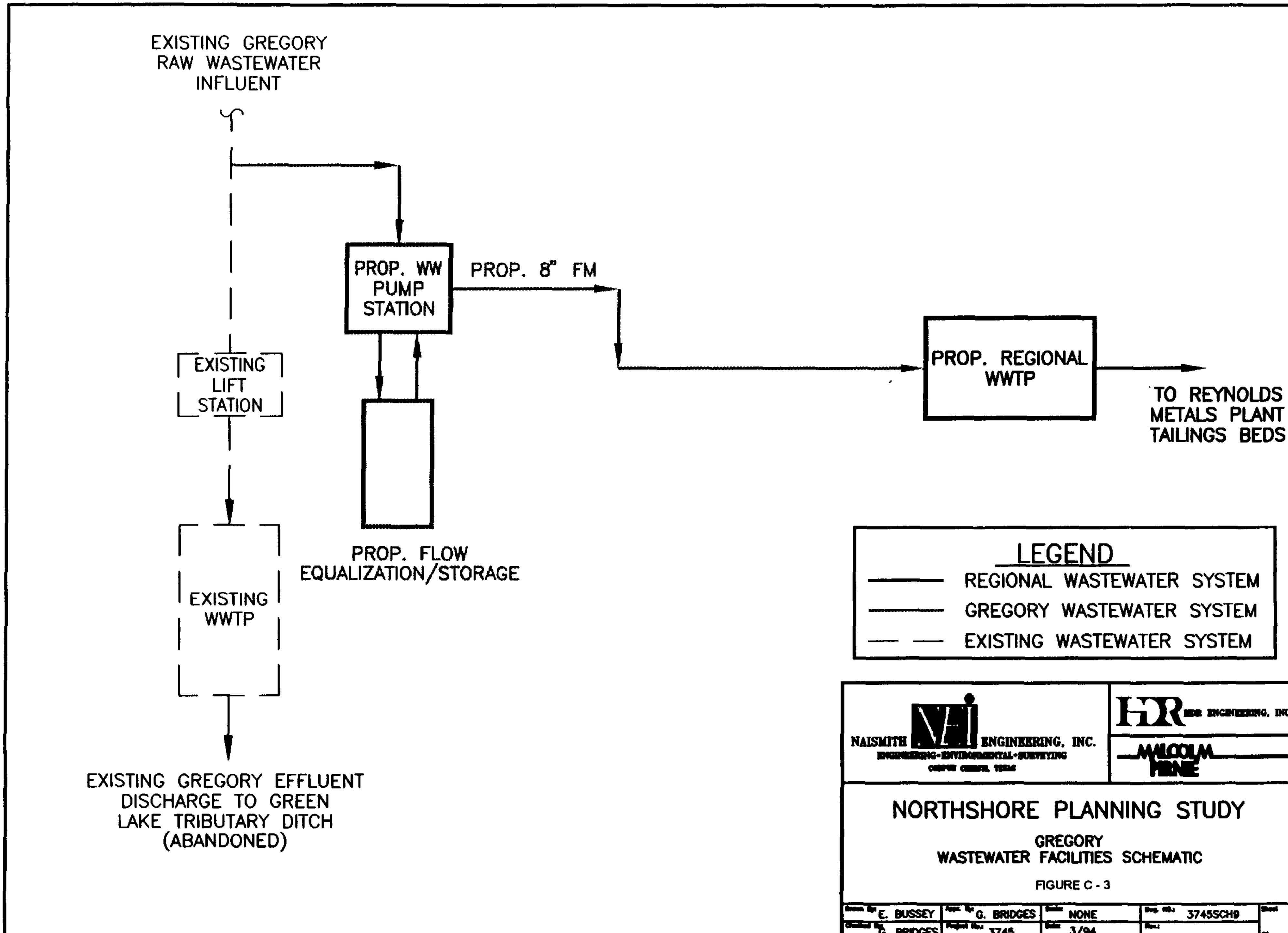
APPENDIX C - TABLE 2
COST ESTIMATE
PORTLAND RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	35,000	$18	$630,000
2.	16" PVC force main	LF	15,000	$29	$435,000
3.	Wastewater pump station at Main Plant	LS	1	$250,000	$250,000
4.	Existing collection system pump station modifications	LS	1	$20,000	$20,000
5.	Highway bore, 24" casing (Hwy. 181)	LF	400	$300	$120,000
6.	Railroad bore, 24" casing (SPRR)	LF	200	$300	$60,000
7.	Ditch crossing for 16" PVC	LS	1	$50,000	$50,000
8.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$1,645,000
Contingency (20%)	$329,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,974,000
Professional Services (15%)	$296,000
Easement/ROW Acquisition	$20,000
TOTAL PROJECT CAPITAL COST	**$2,290,000**

ANNUAL COSTS

Debt Service Sub-Total	$233,000
Operations & Maintenance	$26,000
Power	$23,000
Chemical Addition	$70,000
Sub-Total	$119,000
TOTAL ANNUAL COST	**$352,000**


EXISTING GREGORY RAW WASTEWATER INFLUENT
PROP. WW PUMP STATION
PROP. 8" FM
PROP. REGIONAL WWTP
TO REYNOLDS METALS PLANT TAILINGS BEDS
EXISTING LIFT STATION
PROP. FLOW EQUALIZATION/STORAGE
EXISTING WWTP
EXISTING GREGORY EFFLUENT DISCHARGE TO GREEN LAKE TRIBUTARY DITCH (ABANDONED)
LEGEND
REGIONAL WASTEWATER SYSTEM
GREGORY WASTEWATER SYSTEM
EXISTING WASTEWATER SYSTEM
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HDR ENGINEERING, INC.
MALCOLM PIRNIE
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GREGORY
WASTEWATER FACILITIES SCHEMATIC
FIGURE C - 3
E. BUSSEY
G. BRIDGES
G. BRIDGES
3745
NONE
3/94
3745SCH9

APPENDIX C - TABLE 3
COST ESTIMATE
GREGORY RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	8" PVC force main	LF	9,300	$11	$102,000
2.	Wastewater pump station at WWTP	LS	1	$100,000	$100,000
3.	Flow equalization/storage facilities at WWTP	LS	1	$100,000	$100,000
4.	Highway bore, 16" casing (Hwy. 181)	LF	200	$250	$50,000
5.	Railroad bore, 16" casing (SPRR)	LF	100	$250	25,000
		Sub-Total			$377,000
		Contingency (20%)			$75,000
		TOTAL ESTIMATED CONSTRUCTION COST			$452,000
		Professional Services (18%)			$81,000
		Easement/ROW Acquisition			$10,000
		TOTAL PROJECT CAPITAL COST			**$543,000**
		ANNUAL COSTS			
		Debt Service Sub-Total			$55,000
		Operations & Maintenance			$21,000
		Power			$7,000
		Chemical Addition			$20,000
		Sub-Total			$48,000
		TOTAL ANNUAL COST			**$103,000**

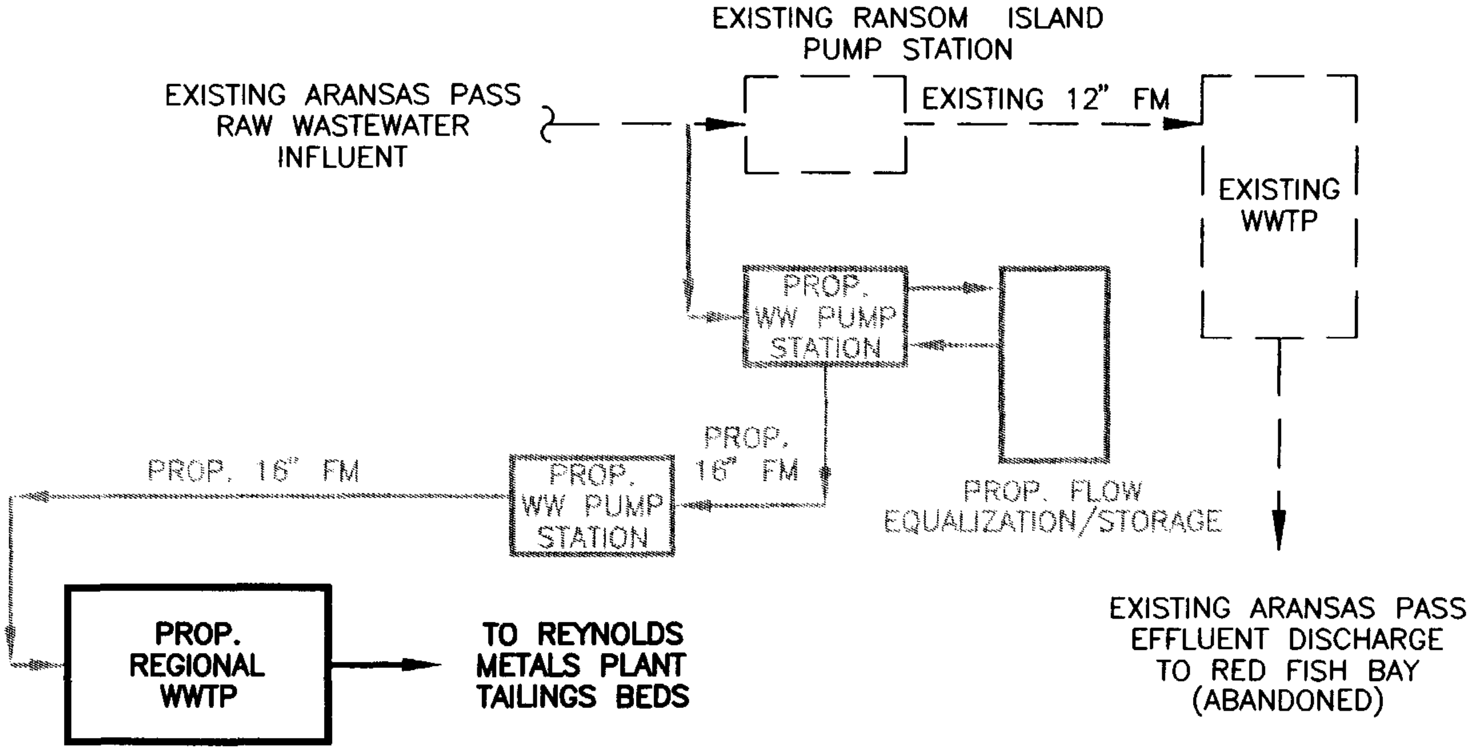
APPENDIX C - TABLE 4
COST ESTIMATE
GREGORY RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTOIN 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	8" PVC force main	LF	18,600	$11	$205,000
2.	Wastewater pump station at WWTP	LS	1	$150,000	$150,000
3.	Highway bore, 16" casing (Hwy. 181)	LF	400	$200	$80,000
4.	Railroad bore, 16" casing (SPRR)	LF	200	$220	44,000

Sub-Total	$479,000
Contingency (20%)	$96,000
TOTAL ESTIMATED CONSTRUCTION COST	$575,000
Professional Services (18%)	$104,000
Easement/ROW Acquisition	$10,000
TOTAL PROJECT CAPITAL COST	**$689,000**

ANNUAL COSTS

Debt Service Sub-Total	$70,000
Operations & Maintenance	$21,000
Power	$7,000
Chemical Addition	$20,000
Sub-Total	$48,000
TOTAL ANNUAL COST	**$118,000**



LEGEND

- REGIONAL WASTEWATER SYSTEM
- ARANSAS PASS WASTEWATER SYSTEM
- EXISTING WASTEWATER SYSTEM

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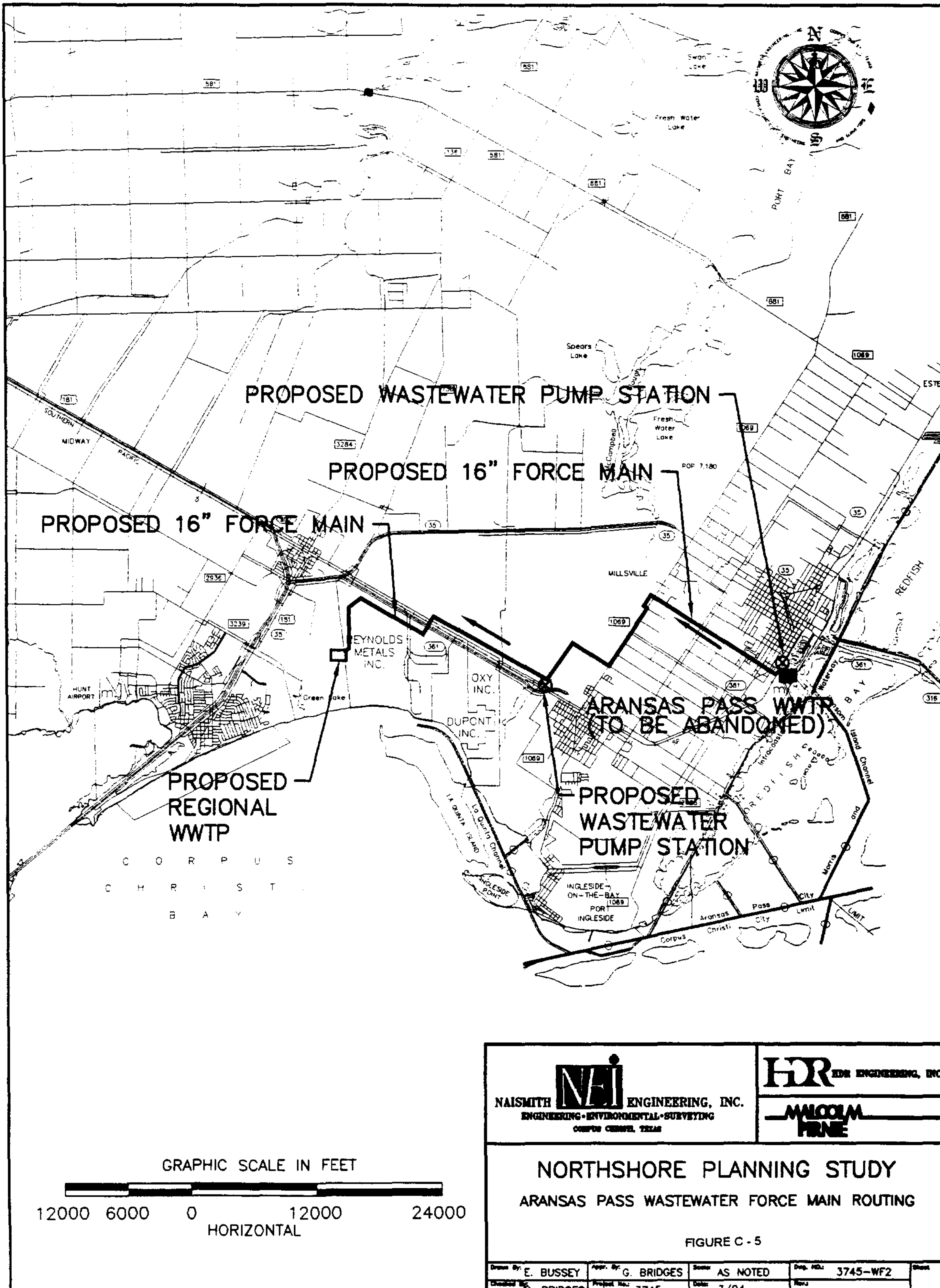
ARANSAS PASS WASTEWATER FACILITIES SCHEMATIC

FIGURE C - 4

Drawn By: A. NORIEGA	Appr. By: G. BRIDGES	Scale: NONE	Dwg. No.: 3745SCH2	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of


PROPOSED WASTEWATER PUMP STATION
PROPOSED 16" FORCE MAIN
PROPOSED 16" FORCE MAIN
PROPOSED REGIONAL WWTP
ARANSAS PASS WWTP (TO BE ABANDONED)
PROPOSED WASTEWATER PUMP STATION
REYNOLDS METALS INC.
OXY INC.
DUPONT INC.
MILLSVILLE
MIDWAY
SOUTHERN PACIFIC
HUNT AIRPORT
Green Lake
Spears Lake
Fresh Water Lake
Swan Lake
PORT BAY
REDFISH BAY
INGLESIDE-ON-THE-BAY
PORT INGLESIDE
INGLESIDE POINT
LA QUINTA ISLAND
La Quinta Channel
CORPUS CHRISTI BAY
Corpus Christi City Limit
Aransas Pass City Limit
GRAPHIC SCALE IN FEET
12000 6000 0 12000 24000
HORIZONTAL
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NORTHSHORE PLANNING STUDY
ARANSAS PASS WASTEWATER FORCE MAIN ROUTING
FIGURE C - 5
Drawn By: E. BUSSEY
Appr. By: G. BRIDGES
Scale: AS NOTED
Dwg. No.: 3745-WF2
Checked By: G. BRIDGES
Project No.: 3745
Date: 3/94

APPENDIX C - TABLE 5
COST ESTIMATE
ARANSAS PASS RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	57,800	$20	$1,156,000
2.	16" PVC force main	LF	4,800	$35	$168,000
3.	New Ransom Island Wastewater Pump Station	LS	1	$150,000	$150,000
4.	Flow equalization/storage facilities at existing WWTP	LS	1	$100,000	$100,000
5.	New wastewater pump station at Hwy. 1069	LS	1	$150,000	$150,000
6.	Highway bore, 24" casing (Hwy. 361)	LF	120	$350	$42,000
7.	Railroad bore, 24" casing (SPRR)	LF	100	$350	$35,000
8.	Highway bore, 24" casing (Hwy. 181)	LF	200	$350	$70,000
9.	Highway Bore, 24" casing (Hwy. 1069)	LF	60	$350	$21,000
10.	Railroad bore, 24" casing (SPRR)	LF	150	$350	$53,000
11.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$2,025,000
Contingency (20%)	$405,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,430,000
Professional Services (14%)	$340,000
Easement/ROW Acquisition	$70,000
TOTAL PROJECT CAPITAL COST	**$2,840,000**

ANNUAL COSTS

Debt Service Sub-Total	$289,000
Operations & Maintenance	$42,000
Power	$44,000
Chemical Addition	$150,000
Sub-Total	$236,000
TOTAL ANNUAL COST	**$525,000**

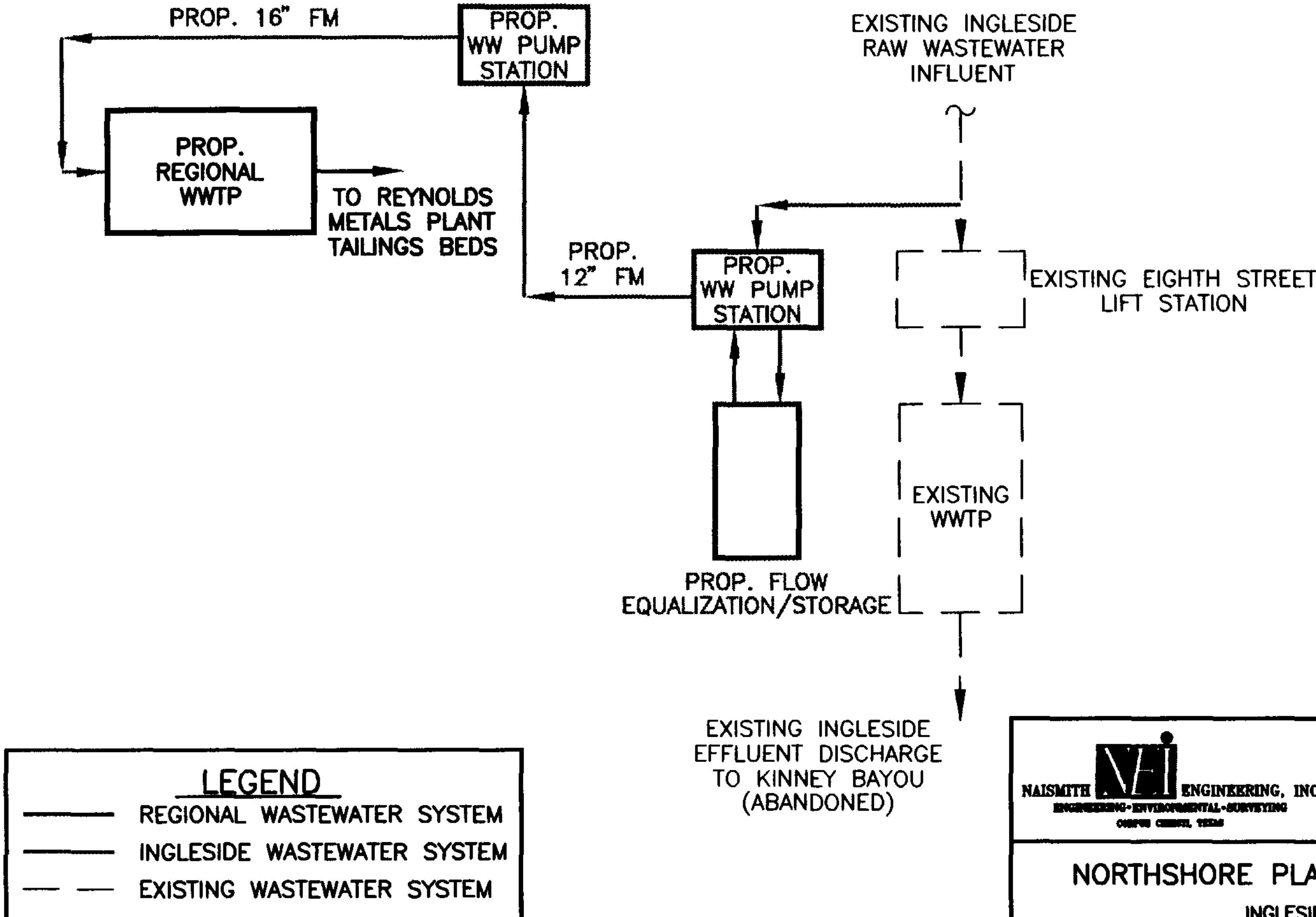
APPENDIX C - TABLE 6
COST ESTIMATE
ARANSAS PASS RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	115,600	$18	$2,081,000
2.	16" PVC force main	LF	9,600	$29	$278,000
3.	New Ransom Island Wastewater Pump Station	LS	1	$200,000	$200,000
4.	New wastewater pump station at Hwy. 1069	LS	1	$200,000	$200,000
5.	Highway bore, 24" casing (Hwy. 361)	LF	240	$300	$72,000
6.	Railroad bore, 24" casing (SPRR)	LF	200	$300	$60,000
7.	Highway bore, 24" casing (Hwy. 181)	LF	400	$300	$120,000
8.	Highway Bore, 24" casing (Hwy. 1069)	LF	120	$300	$36,000
9.	Railroad bore, 24" casing (SPRR)	LF	300	$300	$90,000
10.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$3,217,000
Contingency (20%)	$643,000
TOTAL ESTIMATED CONSTRUCTION COST	$3,860,000
Professional Services (13%)	$502,000
Easement/ROW Acquisition	$70,000
TOTAL PROJECT CAPITAL COST	**$4,432,000**

ANNUAL COSTS

Debt Service Sub-Total	$452,000
Operations & Maintenance	$42,000
Power	$44,000
Chemical Addition	$150,000
Sub-Total	$236,000
TOTAL ANNUAL COST	**$688,000**



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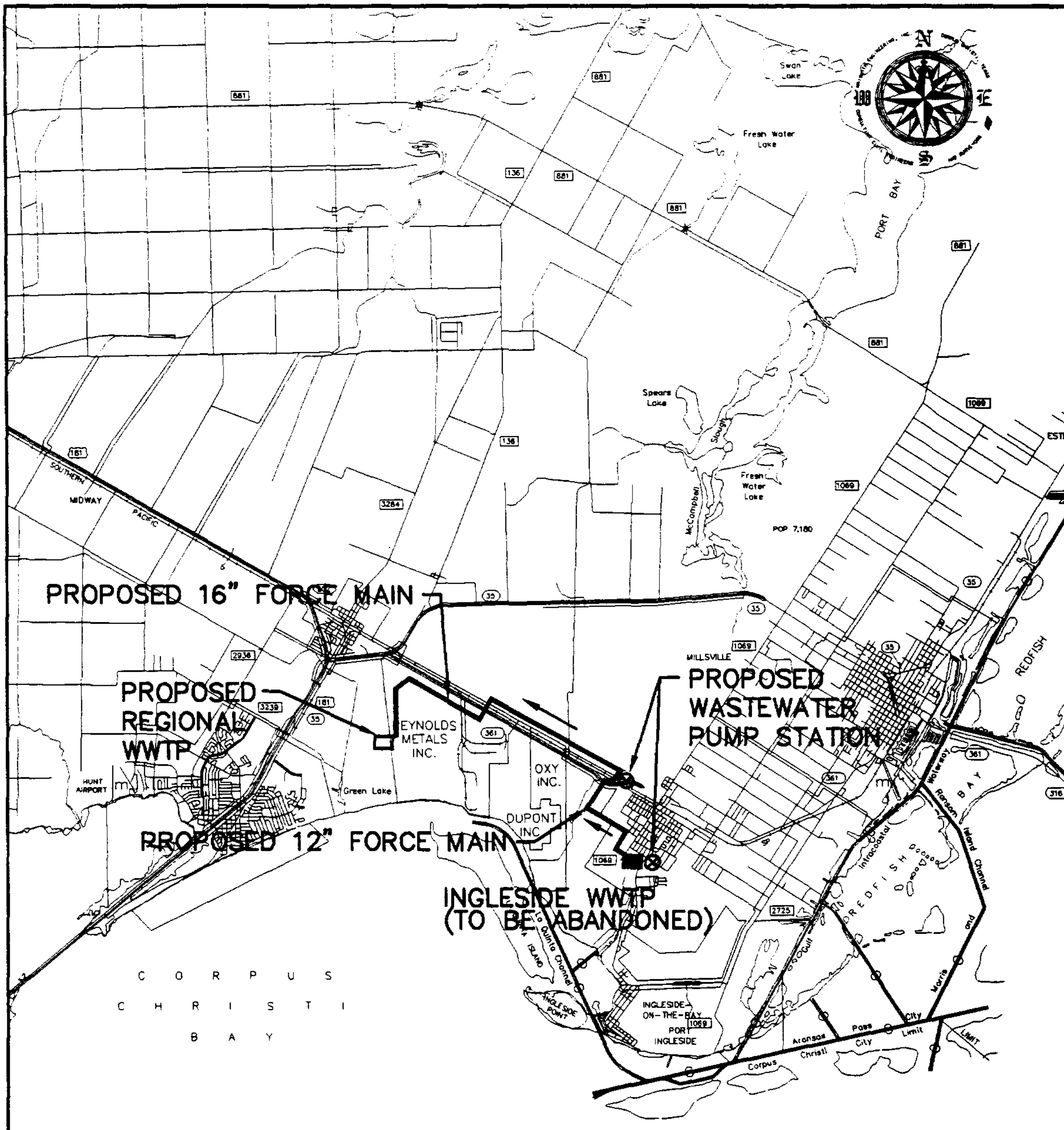
NORTHSHORE PLANNING STUDY

INGLESIDE WASTEWATER FACILITIES SCHEMATIC

FIGURE C - 6

A. NORIEGA	G. BRIDGES	NONE	3745SCH3	
G. BRIDGES	3745	3/94		



GRAPHIC SCALE IN FEET

12000 6000 0 12000 24000
HORIZONTAL

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NORTHSHORE PLANNING STUDY

INGLESIDE WASTEWATER FORCE MAIN ROUTING

FIGURE C - 7

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.: 3745-WF6	Sheet
Checked By: C. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	Of

APPENDIX C - TABLE 7
COST ESTIMATE
INGLESIDE RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC force main	LF	39,100	$15	$587,000
2.	Eighth Street Wastewater Pump Station modifications	LS	1	$100,000	$100,000
3.	Flow equalization/storage facilities at existing WWTP	LS	1	$125,000	$125,000
4.	New wastewater pump station at FM 1069	LS	1	$150,000	$150,000
5.	Highway bore, 20" Casing (Hwy. 181)	LF	400	$300	$120,000
6.	Railroad bore, 20" casing (SPRR)	LF	300	$300	$90,000
7.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$1,252,000
Contingency (20%)	$250,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,502,000
Professional Services (15%)	$225,000
Easement/ROW Acquisition	$40,000
TOTAL PROJECT CAPITAL COST	**$1,767,000**

ANNUAL COSTS

Debt Service Sub-Total	$180,000
Operations & Maintenance	$42,000
Power	$38,000
Chemical Addition	$70,000
Sub-Total	$150,000
TOTAL ANNUAL COST	**$330,000**

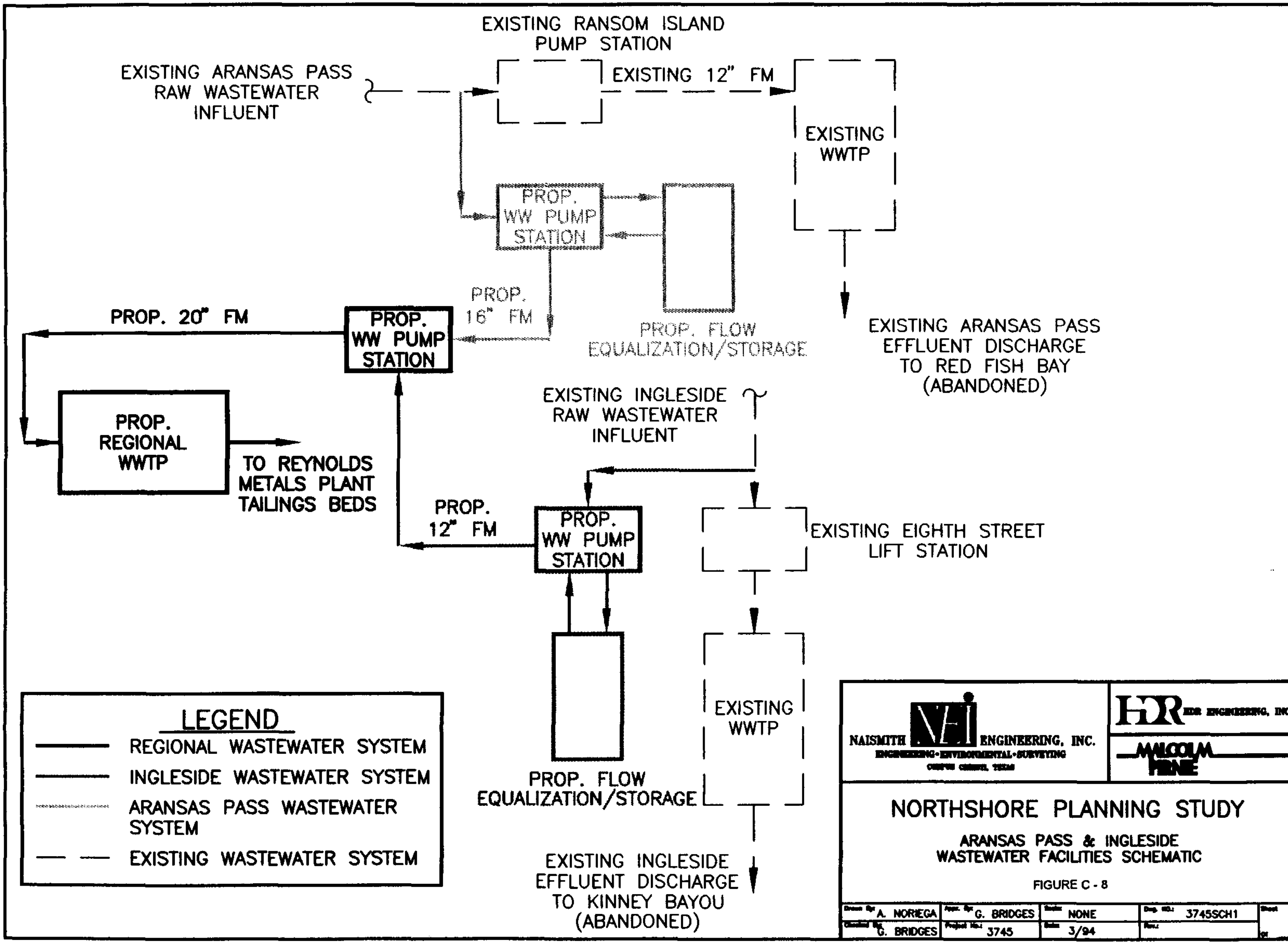
APPENDIX C - TABLE 8
COST ESTIMATE
INGLESIDE RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 2

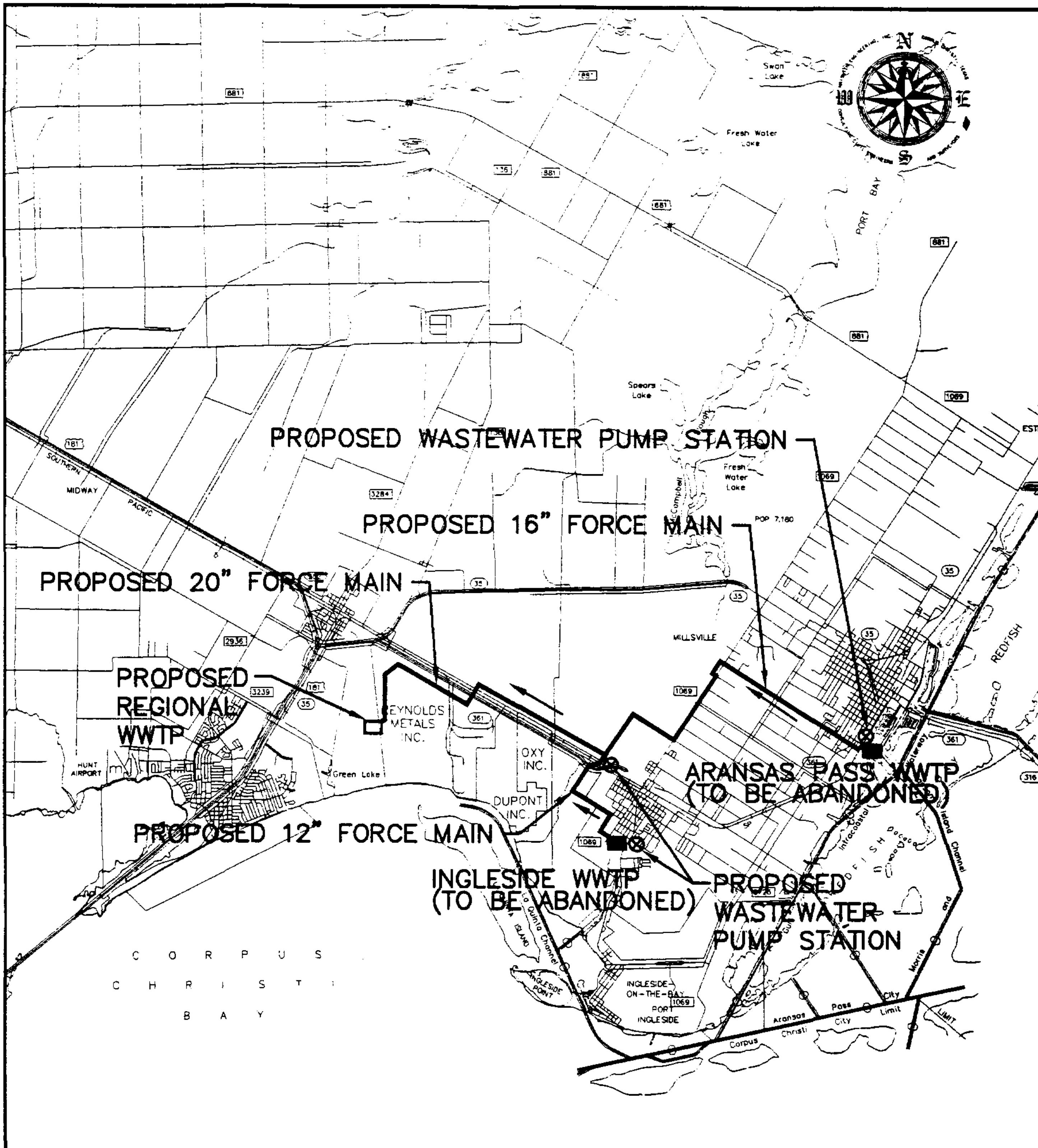
Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC force main	LF	78,200	$12	$938,000
2.	Eighth Street Wastewater Pump Station modifications	LS	1	150,000	$150,000
3.	New wastewater pump station at FM 1069	LS	1	$200,000	$200,000
4.	Highway bore, 20" Casing (Hwy. 181)	LF	800	$250	$200,000
5.	Railroad bore, 20" casing (SPRR)	LF	600	$250	$150,000
6.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$1,718,000
Contingency (20%)	$344,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,062,000
Professional Services (13%)	$268,000
Easement/ROW Acquisition	$40,000
TOTAL PROJECT CAPITAL COST	**$2,370,000**

ANNUAL COSTS

Debt Service Sub-Total	$241,000
Operations & Maintenance	$42,000
Power	$38,000
Chemical Addition	$70,000
Sub-Total	$150,000
TOTAL ANNUAL COST	**$391,000**


EXISTING RANSOM ISLAND PUMP STATION
EXISTING ARANSAS PASS RAW WASTEWATER INFLUENT
EXISTING 12" FM
EXISTING WWTP
PROP. WW PUMP STATION
PROP. 16" FM
PROP. FLOW EQUALIZATION/STORAGE
PROP. 20" FM
PROP. WW PUMP STATION
EXISTING ARANSAS PASS EFFLUENT DISCHARGE TO RED FISH BAY (ABANDONED)
PROP. REGIONAL WWTP
TO REYNOLDS METALS PLANT TAILINGS BEDS
EXISTING INGLESIDE RAW WASTEWATER INFLUENT
PROP. 12" FM
PROP. WW PUMP STATION
EXISTING EIGHTH STREET LIFT STATION
EXISTING WWTP
PROP. FLOW EQUALIZATION/STORAGE
EXISTING INGLESIDE EFFLUENT DISCHARGE TO KINNEY BAYOU (ABANDONED)
LEGEND
REGIONAL WASTEWATER SYSTEM
INGLESIDE WASTEWATER SYSTEM
ARANSAS PASS WASTEWATER SYSTEM
EXISTING WASTEWATER SYSTEM
NAISMITH ENGINEERING, INC.
HDR ENGINEERING, INC.
MALCOLM PIRNIE
NORTHSHORE PLANNING STUDY
ARANSAS PASS & INGLESIDE WASTEWATER FACILITIES SCHEMATIC
FIGURE C - 8
A. NORIEGA
G. BRIDGES
NONE
3745SCH1
G. BRIDGES
3745
3/94



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ARANSAS PASS & INGLESIDE WASTEWATER FORCE MAIN ROUTING

FIGURE C - 9

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-WF5	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

APPENDIX C - TABLE 9
COST ESTIMATE
ARANSAS PASS RAW WASTEWATER FACILITIES (COMBINED WITH INGLESIDE)
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	28,100	$20	$562,000
2.	16" PVC force main	LF	4,800	$35	$168,000
3.	New Ransom Island Wastewater Pump Station	LS	1	$150,000	$150,000
4.	Flow equalization/storage facilities at existing WWTP or Pump Station site	LS	1	$100,000	$100,000
5.	Highway bore, 24" casing (Hwy. 361)	LF	120	$350	$42,000
6.	Railroad bore, 24" casing (SPRR)	LF	100	$350	$35,000
7.	Highway bore, 24" casing (Hwy. 1069)	LF	60	$350	$21,000
8.	20" PVC force main	LF	29,700	$30 (66%)	$588,000
9.	New wastewater pump station at FM 1069	LS	1	$150,000 (66%)	$99,000
10.	Highway bore, 26" casing (Hwy. 181)	LF	200	$400 (66%)	$53,000
11.	Railroad bore, 26" casing (SPRR)	LF	150	$400 (66%)	$40,000
12.	Odor control facilities	LS	1	$80,000 (66%)	$53,000

Sub-Total	$1,911,000
Contingency (20%)	$382,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,293,000
Professional Services (14%)	$321,000
Easement/ROW Acquisition	$52,000
TOTAL PROJECT CAPITAL COST	**$2,666,000**

ANNUAL COSTS

Debt Service Sub-Total	$272,000
Operations & Maintenance	$36,000
Power	$46,000
Chemical Addition	$120,000
Sub-Total	$202,000
TOTAL ANNUAL COST	**$474,000**

APPENDIX C - TABLE 10
COST ESTIMATE
ARANSAS PASS RAW WASTEWATER FACILITIES (COMBINED WITH INGLESIDE)
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	56,200	$18	**$1,012,000**
2.	16" PVC force main	LF	9,600	$29	**$278,000**
3.	New Ransom Island Wastewater Pump Station	LS	1	$200,000	**$200,000**
4.	Highway bore, 24" casing (Hwy. 361)	LF	240	$300	**$72,000**
5.	Railroad bore, 24" casing (SPRR)	LF	200	$300	**$60,000**
6.	Highway bore, 24" casing (Hwy. 1069)	LF	120	$300	**$36,000**
7.	20" PVC force main	LF	59,400	$26 (66%)	**$1,019,000**
8.	New wastewater pump station at FM 1069	LS	1	$200,000 (66%)	**$132,000**
9.	Highway bore, 26" casing (Hwy. 181)	LF	400	$350 (66%)	**$92,000**
10.	Railroad bore, 26" casing (SPRR)	LF	300	$350 (66%)	**$69,000**
11.	Odor control facilities	LS	1	$80,000 (66%)	**$53,000**
		Sub-Total			$3,023,000
		Contingency (20%)			$605,000
		TOTAL ESTIMATED CONSTRUCTION COST			$3,628,000
		Professional Services (13%)			$472,000
		Easement/ROW Acquisition			$52,000
		TOTAL PROJECT CAPITAL COST			**$4,152,000**

ANNUAL COSTS

Debt Service Sub-Total	$423,000
Operations & Maintenance	$36,000
Power	$46,000
Chemical Addition	$120,000
Sub-Total	$202,000
TOTAL ANNUAL COST	**$625,000**

APPENDIX C - TABLE 11
COST ESTIMATE
INGLESIDE RAW WASTEWATER FACILITIES (COMBINED WITH ARANSAS PASS)
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC Force Main	LF	9,400	$15	$141,000
2.	Eighth Street Wastewater Pump Station modification	LS	1	$100,000	$100,000
3.	Flow equalization/storage facilities at Existing WWTP pump station	LS	1	$125,000	$125,000
4.	Highway bore, 20" casing (Hwy. 181)	LF	200	$300	$60,000
5.	Railroad bore, 20" casing (SPRR)	LF	150	$300	$45,000
6.	20" PVC force main	LF	29,700	$30 (34%)	$303,000
7.	New wastewater pump station at FM 1069	LS	1	$150,000 (34%)	$51,000
8.	Highway bore, 26" casing (Hwy. 181)	LF	200	$400 (34%)	$27,000
9.	Railroad bore, 26" casing (SPRR)	LF	150	$400 (34%)	$20,000
10.	Odor control facilities	LS	1	$80,000 (34%)	$27,000

Sub-Total	$899,000
Contingency (20%)	$180,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,079,000
Professional Services (15%)	$162,000
Easement/ROW Acquisition	$20,000
TOTAL PROJECT CAPITAL COST	**$1,261,000**

ANNUAL COSTS

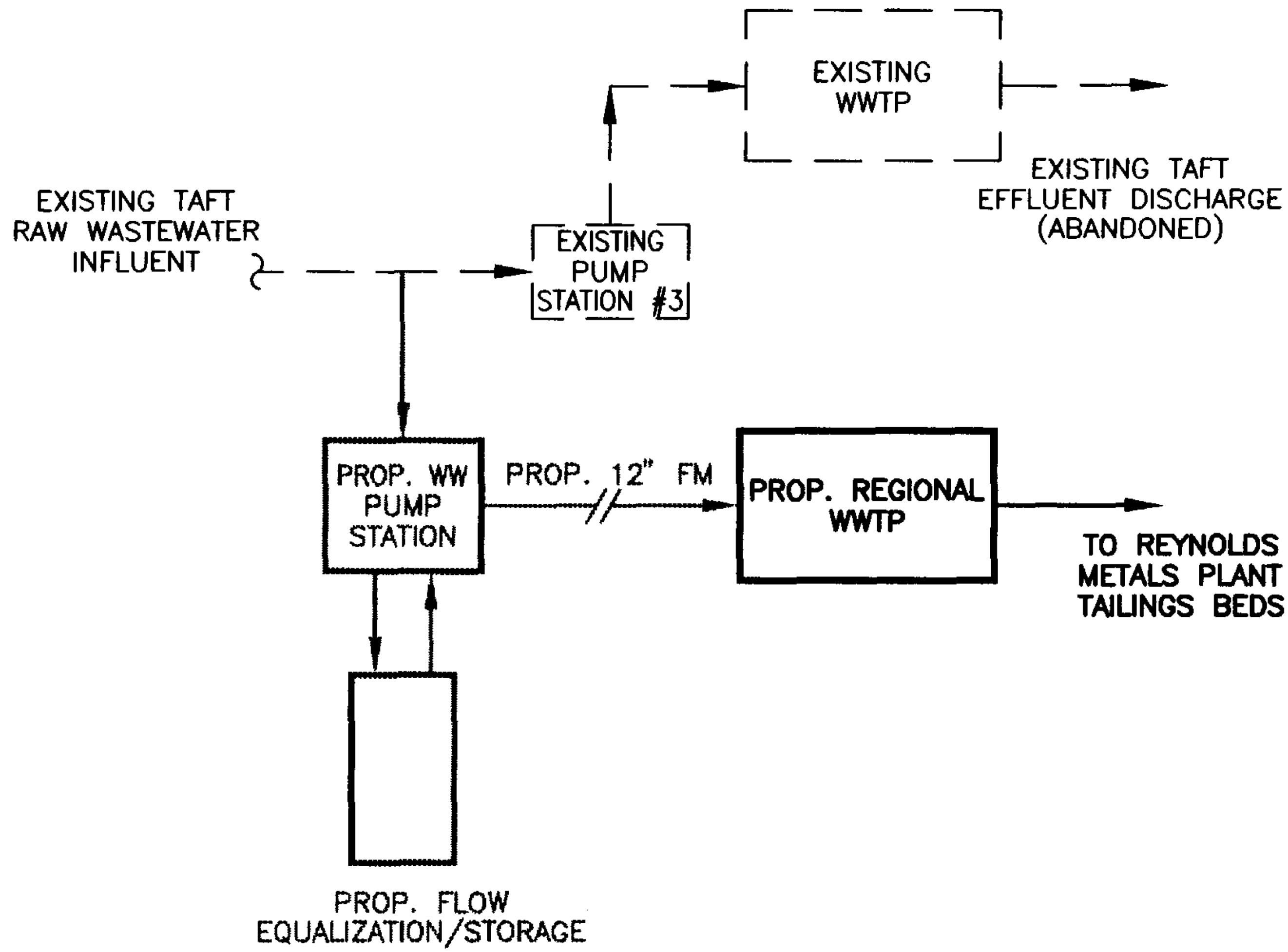
Debt Service Sub-Total	$128,000
Operations & Maintenance	$30,000
Power	$29,000
Chemical Addition	$40,000
Sub-Total	$99,000
TOTAL ANNUAL COST	**$227,000**

APPENDIX C - TABLE 12
COST ESTIMATE
INGLESIDE RAW WASTEWATER FACILITIES (COMBINED WITH ARANSAS PASS)
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC Force Main	LF	18,800	$12	$226,000
2.	Eighth Street Wastewater Pump Station modification	LS	1	$150,000	$150,000
3.	Highway bore, 20" casing (Hwy. 181)	LF	400	$250	$100,000
4.	Railroad bore, 20" casing (SPRR)	LF	300	$250	$75,000
5.	20" PVC force main	LF	59,400	$26 (34%)	$525,000
6.	New wastewater pump station at FM 1069	LS	1	$200,000 (34%)	$68,000
7.	Highway bore, 26" casing (Hwy. 181)	LF	400	$350 (34%)	$48,000
8.	Railroad bore, 26" casing (SPRR)	LF	300	$350 (34%)	$36,000
9.	Odor control facilities	LS	1	$80,000 (34%)	$27,000
		Sub-Total			$1,255,000
		Contingency (20%)			$251,000
		TOTAL ESTIMATED CONSTRUCTION COST			$1,506,000
		Professional Services (15%)			$226,000
		Easement/ROW Acquisition			$20,000
		TOTAL PROJECT CAPITAL COST			**$1,752,000**

ANNUAL COSTS

Debt Service Sub-Total	$179,000
Operations & Maintenance	$30,000
Power	$29,000
Chemical Addition	$40,000
Sub-Total	$99,000
TOTAL ANNUAL COST	**$278,000**



LEGEND

- REGIONAL WASTEWATER SYSTEM
- TAFT WASTEWATER SYSTEM
- EXISTING WASTEWATER SYSTEM

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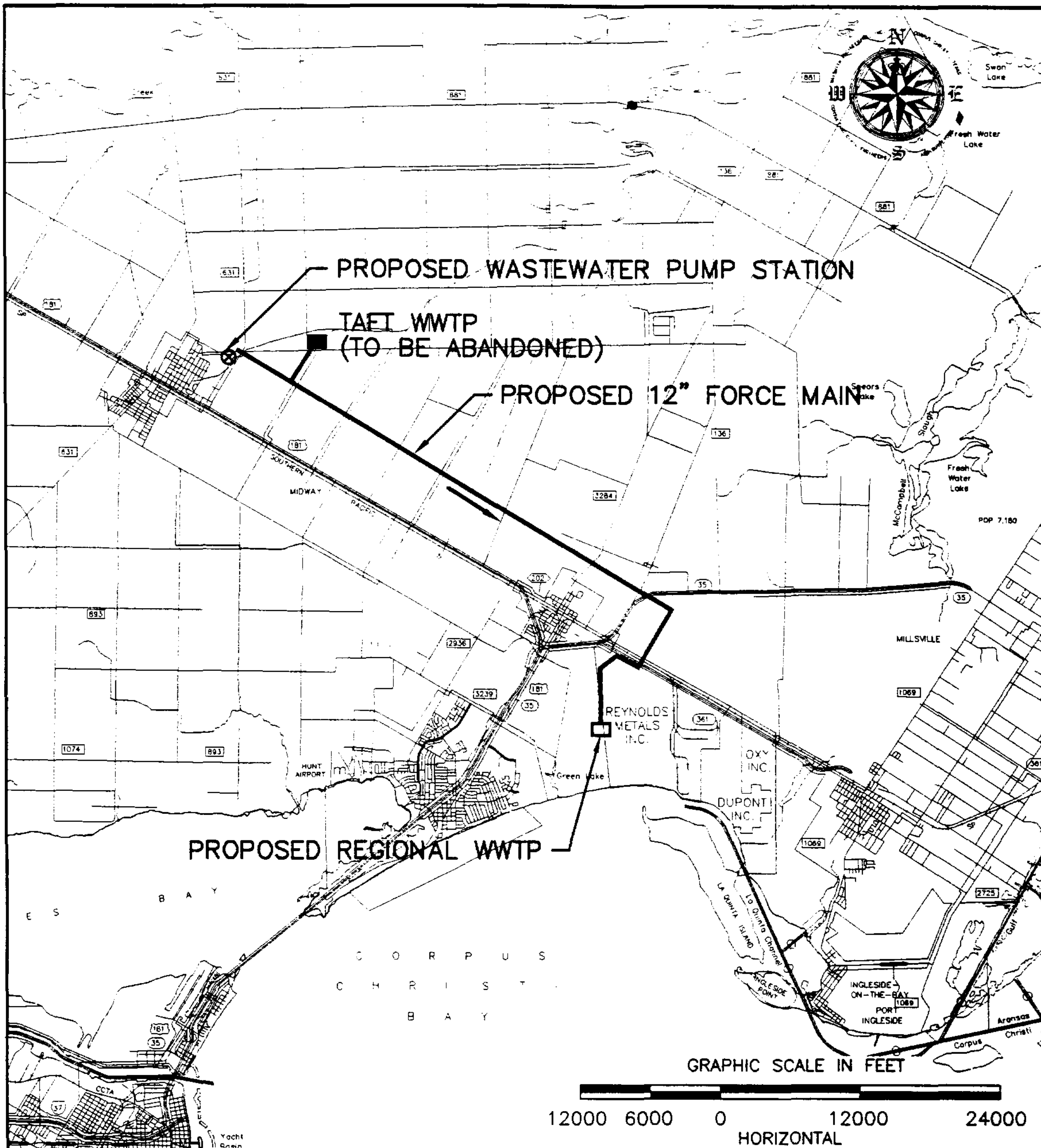
TAFT WASTEWATER FACILITIES SCHEMATIC

FIGURE C - 10

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: NONE	Dwg. No.: 3745SC13	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of



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TAFT WASTEWATER FORCE MAIN ROUTING

FIGURE C - 11

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. No.: 3745-WF1
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:

APPENDIX C - TABLE 13
COST ESTIMATE
TAFT RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC force main	LF	55,000	$15	$825,000
2.	Wastewater pump station #3 modifications	LS	1	$100,000	$100,000
3.	Flow equalization/storage facilities at Pump Station #3 site	LS	1	$100,000	$100,000
4.	Highway bore, 20" casing (Hwy. 136)	LF	100	$300	$30,000
5.	Highway bore, 20" casing (Hwy. 181)	LF	200	$300	$60,000
6.	Highway bore, 20" casing (Hwy. 631)	LF	100	$300	$30,000
7.	Highway bore, 20" casing (Hwy. 35)	LF	100	$300	$30,000
8.	Railroad bore, 20" casing (SPRR)	LF	150	$300	$45,000

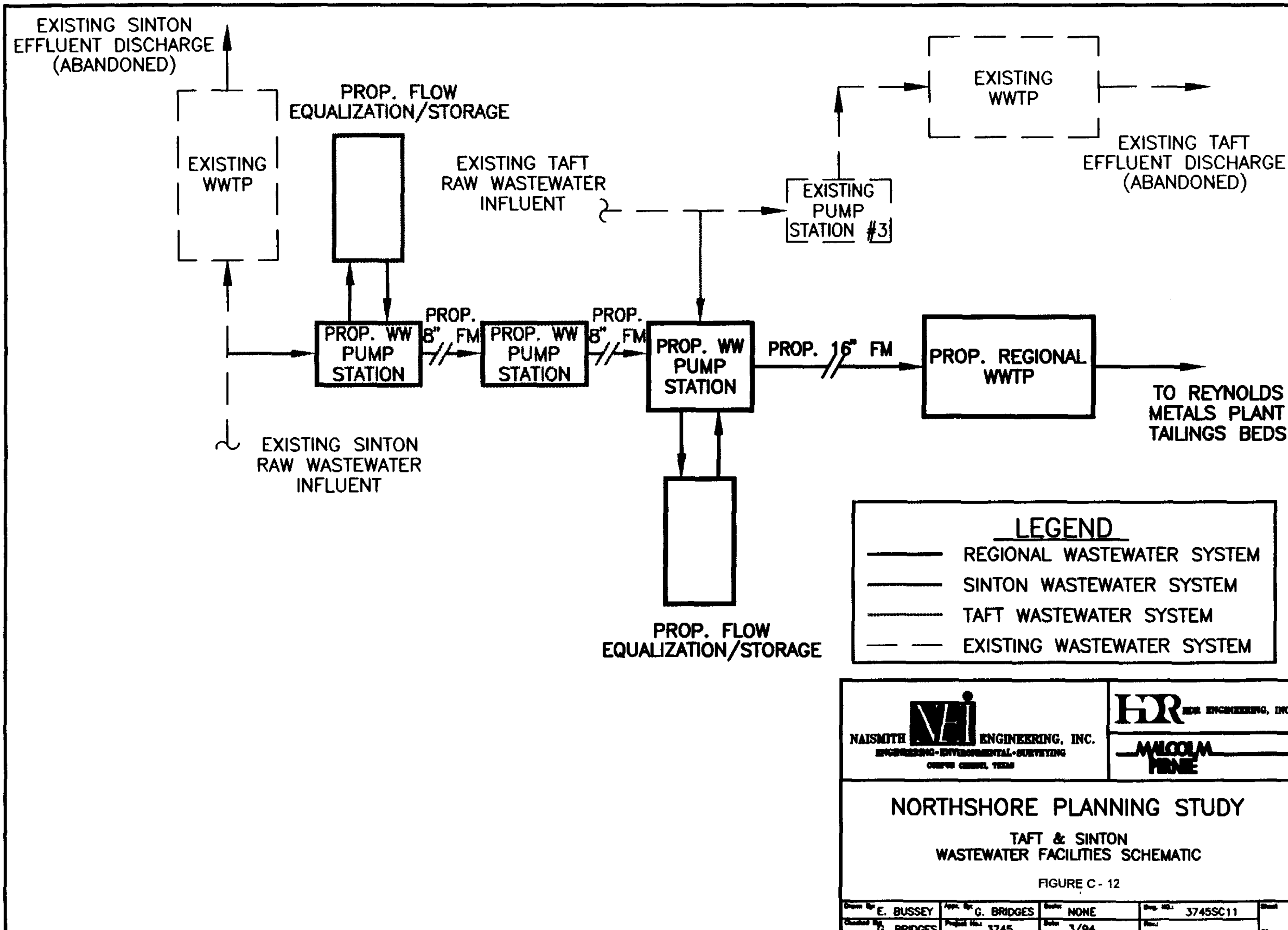
Sub-Total	$1,220,000
Contingency (20%)	$244,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,464,000
Professional Services (15%)	$220,000
Easement/ROW Acquisition	$60,000
TOTAL PROJECT CAPITAL COST	**$1,744,000**

ANNUAL COSTS

Debt Service Sub-Total	$178,000
Operations & Maintenance	$21,000
Power	$7,000
Chemical Addition	$70,000
Sub-Total	$98,000
TOTAL ANNUAL COST	**$276,000**

APPENDIX C - TABLE 14
COST ESTIMATE
TAFT RAW WASTEWATER FACILITIES
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC force main	LF	110,000	$12	$1,320,000
2.	Wastewater pump station #3 modifications	LS	1	$150,000	$150,000
3.	Highway bore, 20" casing (Hwy. 136)	LF	200	$250	$50,000
4.	Highway bore, 20" casing (Hwy. 181)	LF	400	$250	$100,000
5.	Highway bore, 20" casing (Hwy. 631)	LF	200	$250	$50,000
6.	Highway bore, 20" casing (Hwy. 35)	LF	200	$250	$50,000
7.	Railroad bore, 20" casing (SPRR)	LF	300	$250	$75,000
	Sub-Total				$1,795,000
	Contingency (20%)				$359,000
	TOTAL ESTIMATED CONSTRUCTION COST				$2,154,000
	Professional Services (13%)				$280,000
	Easement/ROW Acquisition				$60,000
	TOTAL PROJECT CAPITAL COST				**$2,494,000**
	ANNUAL COSTS				
	Debt Service Sub-Total				$254,000
	Operations & Maintenance				$21,000
	Power				$7,000
	Chemical Addition				$70,000
	Sub-Total				$98,000
	TOTAL ANNUAL COST				**$352,000**



EXISTING SINTON EFFLUENT DISCHARGE (ABANDONED)
EXISTING WWTP
PROP. FLOW EQUALIZATION/STORAGE
EXISTING TAFT RAW WASTEWATER INFLUENT
EXISTING PUMP STATION #3
EXISTING WWTP
EXISTING TAFT EFFLUENT DISCHARGE (ABANDONED)
PROP. WW PUMP STATION
PROP. 8" FM
PROP. WW PUMP STATION
PROP. 8" FM
PROP. WW PUMP STATION
PROP. 16" FM
PROP. REGIONAL WWTP
TO REYNOLDS METALS PLANT TAILINGS BEDS
EXISTING SINTON RAW WASTEWATER INFLUENT
PROP. FLOW EQUALIZATION/STORAGE
LEGEND
REGIONAL WASTEWATER SYSTEM
SINTON WASTEWATER SYSTEM
TAFT WASTEWATER SYSTEM
EXISTING WASTEWATER SYSTEM
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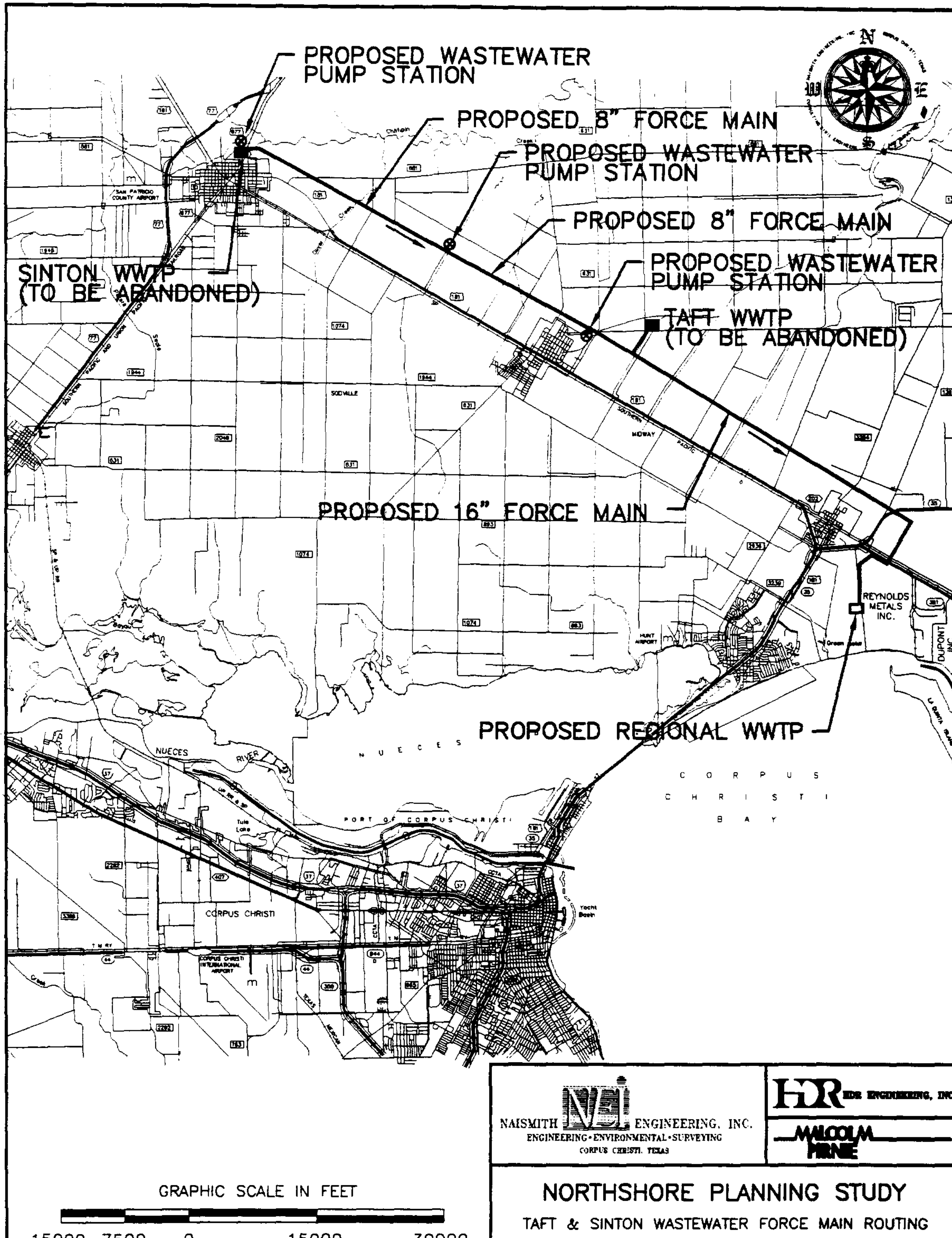
NORTHSHORE PLANNING STUDY
TAFT & SINTON WASTEWATER FACILITIES SCHEMATIC
FIGURE C - 12
E. BUSSEY
G. BRIDGES
G. BRIDGES
3745
NONE
3/94
3745SC11



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NORTHSHORE PLANNING STUDY

TAFT & SINTON WASTEWATER FORCE MAIN ROUTING

FIGURE C - 13

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-WF4	Sheet
Checked By: G. BRIDGES	Project No.: 3745	Date: 3/94	Rev.:	of

APPENDIX C - TABLE 15
COST ESTIMATE
TAFT RAW WASTEWATER FACILITIES (COMBINED WITH SINTON)
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	Flow equalization/storage facilities at Pump Station #3 site	LS	1	$100,000	$100,000
2.	16" PVC force main	LF	55,000	$20 (50%)	$550,000
3.	Wastewater Pump Station #3 modifications	LS	1	$150,000 (50%)	$75,000
4.	Highway bore, 24" casing (Hwy. 631)	LF	100	$350 (50%)	$18,000
5.	Highway bore, 24" casing (Hwy. 136)	LF	100	$350 (50%)	$18,000
6.	Highway bore, 24" casing (Hwy. 35)	LF	100	$350 (50%)	$18,000
7.	Highway bore, 24" casing (Hwy. 181)	LF	200	$350 (50%)	$35,000
8.	Railroad bore, 24" casing (SPRR)	LF	150	$350 (50%)	$26,000

Sub-Total	$840,000
Contingency (20%)	$168,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,008,000
Professional Services (15%)	$151,000
Easement/ROW Acquisition	$30,000
TOTAL PROJECT CAPITAL COST	**$1,189,000**

ANNUAL COSTS

Debt Service Sub-Total	$121,000
Operations & Maintenance	$21,000
Power	$9,000
Chemical Addition	$30,000
Sub-Total	$60,000
TOTAL ANNUAL COST	**$181,000**

APPENDIX C - TABLE 16
COST ESTIMATE
TAFT RAW WASTEWATER FACILITIES (COMBINED WITH SINTON)
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	16" PVC force main	LF	110,000	$18 (50%)	$990,000
2.	Wastewater Pump Station #3 modifications	LS	1	$200,000 (50%)	$100,000
3.	Highway bore, 24" casing (Hwy. 631)	LF	200	$300 (50%)	$30,000
4.	Highway bore, 24" casing (Hwy. 136)	LF	200	$300 (50%)	$30,000
5.	Highway bore, 24" casing (Hwy. 35)	LF	200	$300 (50%)	$30,000
6.	Highway bore, 24" casing (Hwy. 181)	LF	400	$300 (50%)	$60,000
7.	Railroad bore, 24" casing (SPRR)	LF	300	$300 (50%)	$45,000

Sub-Total	$1,285,000
Contingency (20%)	$257,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,542,000
Professional Services (15%)	$231,000
Easement/ROW Acquisition	$30,000
TOTAL PROJECT CAPITAL COST	**$1,803,000**

ANNUAL COSTS

Debt Service Sub-Total	$184,000
Operations & Maintenance	$21,000
Power	$9,000
Chemical Addition	$30,000
Sub-Total	$60,000
TOTAL ANNUAL COST	**$244,000**

APPENDIX C - TABLE 17
COST ESTIMATE
SINTON RAW WASTEWATER FACILITIES (COMBINED WITH TAFT)
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC force main	LF	46,800	$15	$702,000
2.	Wastewater pump station at WWTP	LS	1	$150,000	$150,000
3.	Flow equalization/storage facilities at WWTP	LS	1	$100,000	$100,000
4.	Highway bore, 20" casing (Hwy. 881)	LF	120	$300	$36,000
5.	Creek crossing	LS	1	$30,000	$30,000
6.	Wastewater pump station (midway between Sinton and Taft)	LS	1	$150,000	$150,000
7.	16" PVC force main	LF	55,000	$20 (50%)	$550,000
8.	Wastewater Pump Station #3 modifications (located in Taft)	LS	1	$150,000 (50%)	$75,000
9.	Highway bore, 24" casing (Hwy. 631)	LF	100	$350 (50%)	$18,000
10.	Highway bore, 24" casing (Hwy. 136)	LF	100	$350 (50%)	$18,000
11.	Highway bore, 24" casing (Hwy. 35)	LF	100	$350 (50%)	$18,000
12.	Highway bore, 24" casing (Hwy. 181)	LF	200	$350 (50%)	$35,000
13.	Railroad bore, 24" casing (SPRR)	LF	150	$350 (50%)	$26,000
14.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$1,988,000
Contingency (20%)	$398,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,386,000
Professional Services (13%)	$310,000
Easement/ROW Acquisition	$80,000
TOTAL PROJECT CAPITAL COST	**$2,776,000**

ANNUAL COSTS

Debt Service Sub-Total	$283,000
Operations & Maintenance	$42,000
Power	$9,000
Chemical Addition	$120,000
Sub-Total	$171,000
TOTAL ANNUAL COST	**$454,000**

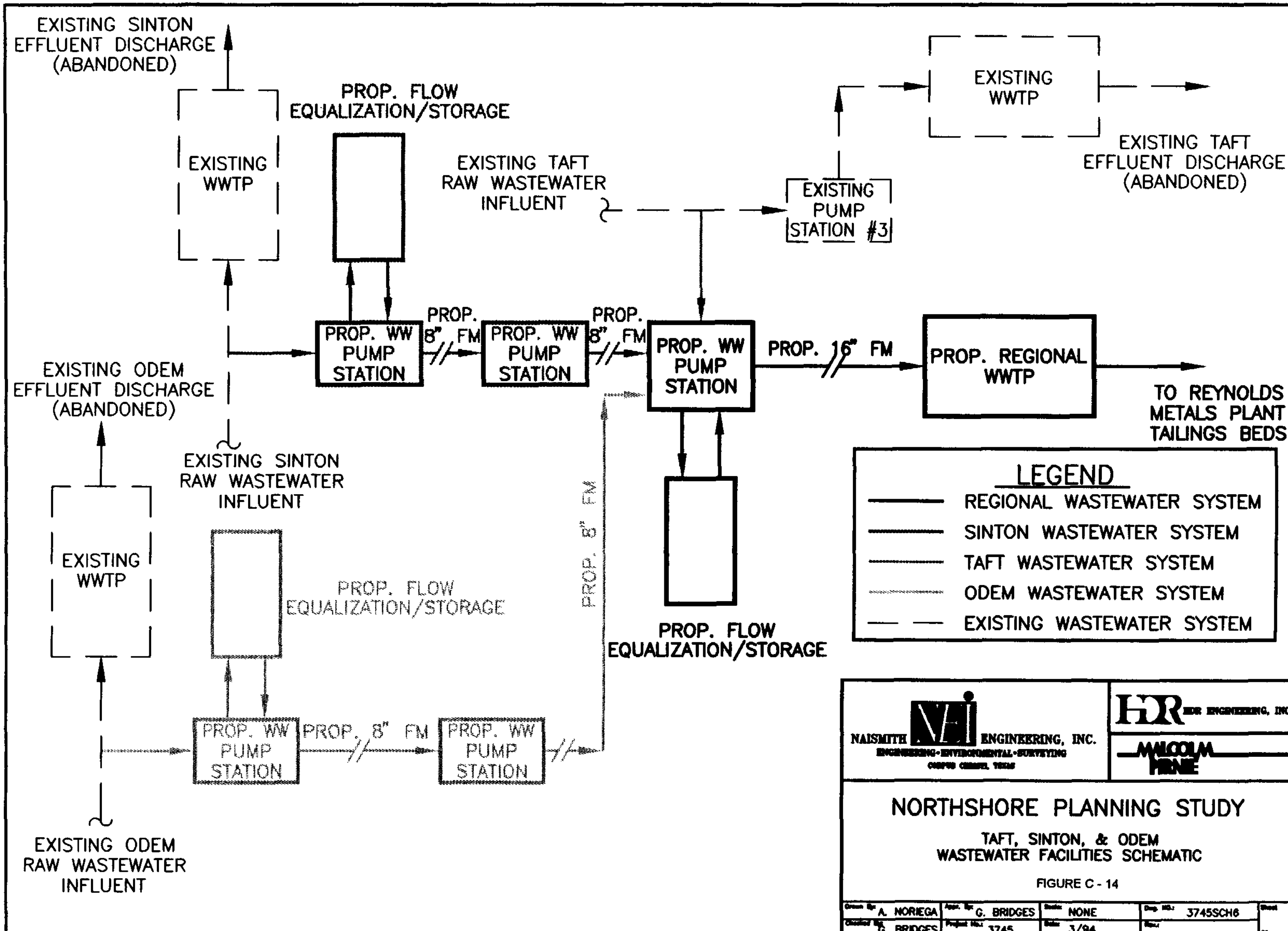
APPENDIX C - TABLE 18
COST ESTIMATE
SINTON RAW WASTEWATER FACILITIES (COMBINED WITH TAFT)
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	12" PVC force main	LF	93,600	$12	$1,123,000
2.	Wastewater pump station at WWTP	LS	1	$200,000	$200,000
3.	Highway bore, 20" casing (Hwy. 881)	LF	240	$250	$60,000
4.	Creek crossing	LS	1	$30,000	$30,000
5.	Wastewater pump station (midway between Sinton and Taft)	LS	1	$200,000	$200,000
6.	16" PVC force main	LF	110,000	$18 (50%)	$990,000
7.	Wastewater Pump Station #3 modifications (located in Taft)	LS	1	$200,000 (50%)	$100,000
8.	Highway bore, 24" casing (Hwy. 631)	LF	200	$300 (50%)	$30,000
9.	Highway bore, 24" casing (Hwy. 136)	LF	200	$300 (50%)	$30,000
10.	Highway bore, 24" casing (Hwy. 35)	LF	200	$300 (50%)	$30,000
11.	Highway bore, 24" casing (Hwy. 181)	LF	400	$300 (50%)	$60,000
12.	Railroad bore, 24" casing (SPRR)	LF	300	$300 (50%)	$45,000
13.	Odor control facilities	LS	1	$80,000	$80,000

Sub-Total	$2,978,000
Contingency (20%)	$596,000
TOTAL ESTIMATED CONSTRUCTION COST	$3,574,000
Professional Services (12%)	$429,000
Easement/ROW Acquisition	$80,000
TOTAL PROJECT CAPITAL COST	**$4,083,000**

ANNUAL COSTS

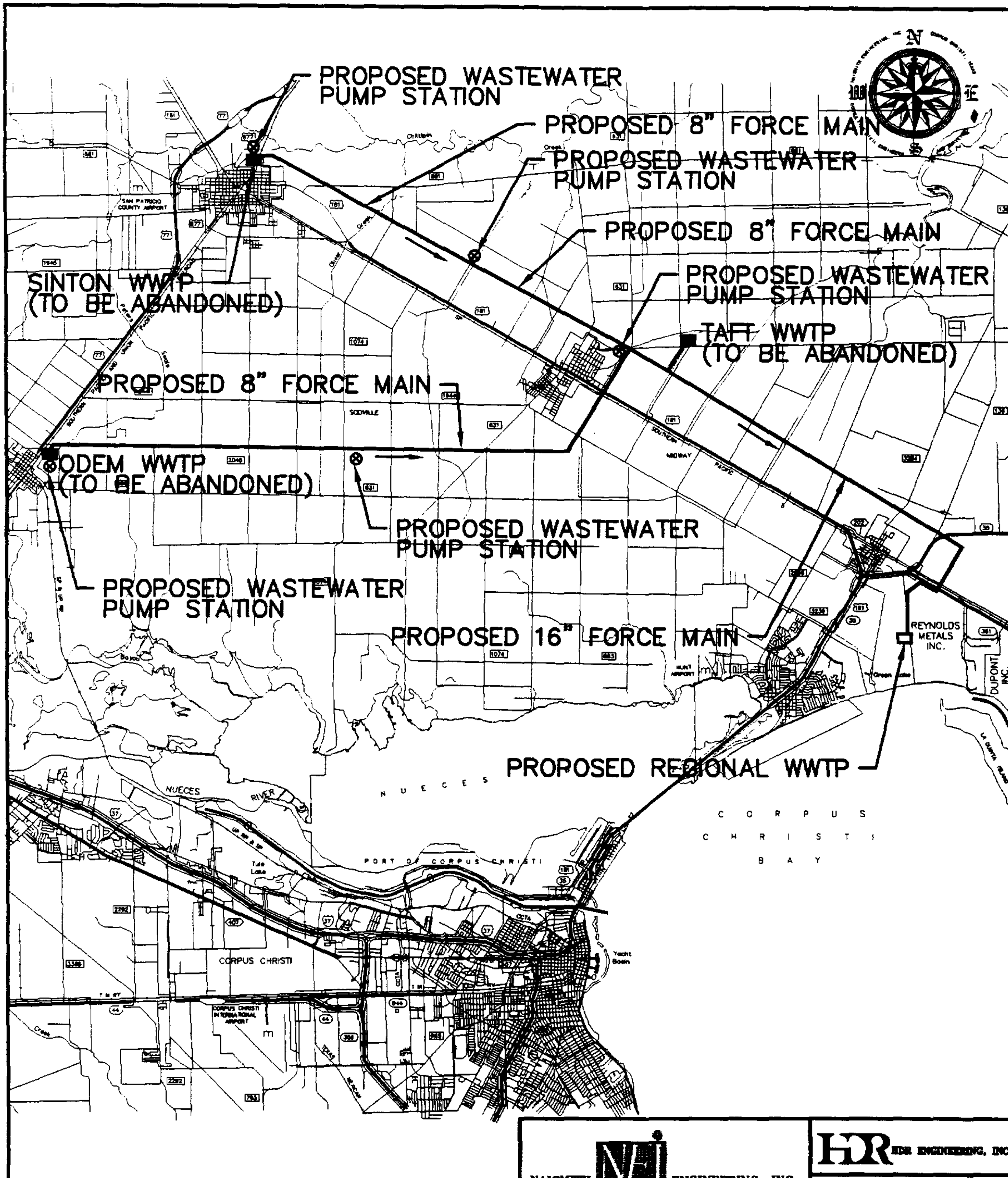
Debt Service Sub-Total	$416,000
Operations & Maintenance	$42,000
Power	$9,000
Chemical Addition	$120,000
Sub-Total	$171,000
TOTAL ANNUAL COST	**$587,000**



NORTHSHORE PLANNING STUDY

TAFT, SINTON, & ODEM WASTEWATER FACILITIES SCHEMATIC

FIGURE C - 14



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GRAPHIC SCALE IN FEET

15000 7500 0 15000 30000

HORIZONTAL

NORTHSHORE PLANNING STUDY

TAFT, SINTON, & ODEM
WASTEWATER FORCE MAIN ROUTING

FIGURE C - 15

Drawn By: E. BUSSEY	Appr. By: G. BRIDGES	Scale: AS NOTED	Dwg. NO.: 3745-WF3
Checked By: G. BRIDGES	Project No.: 3745	Date: 5/94	Rev.:

APPENDIX C - TABLE 19
COST ESTIMATE
ODEM RAW WASTEWATER FACILITIES (COMBINED WITH SINTON & TAFT)
REGIONAL WWTP ALTERNATIVE - OPTION 1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	8" PVC force main	LF	70,100	$11	$771,000
2.	Wastewater pump station at WWTP	LS	1	$120,000	$120,000
3.	Flow equalization/storage facilities at existing WWTP	LS	1	$60,000	$60,000
4.	New wastewater pump station (midway between Odem and Taft)	LS	1	$100,000	$100,000
5.	Peters Swale Crossing	LS	1	$30,000	$30,000
6.	Highway bore, 16" casing (Hwy. 2046, 1074, 631, 893, 181)	LF	440	$250	$110,000
7.	Railroad bore, 16" casing (SPRR)	LF	200	$250	$50,000
8.	16" PVC force main	LF	55,000	$20 (10%)	$110,000
9.	Wastewater Pump Station #3 modifications (located in Taft)	LS	1	$150,000 (10%)	$15,000
10.	Highway bore, 24" casing (Hwy. 631, 136, 35, 181)	LF	500	$350 (10%)	$18,000
11.	Railroad bore, 24" Casing (SPRR)	LF	150	$350 (10%)	$5,000
12.	Odor control facilities	LS	1	$80,000 (50%)	$40,000

Sub-Total	$1,429,000
Contingency (20%)	$286,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,715,000
Professional Services (15%)	$257,000
Easement/ROW Acquisition	$76,000
TOTAL PROJECT CAPITAL COST	**$2,048,000**

ANNUAL COSTS

Debt Service Sub-Total	$209,000
Operations & Maintenance	$42,000
Power	$16,000
Chemical Addition	$60,000
Sub-Total	$118,000
TOTAL ANNUAL COST	**$327,000**

APPENDIX C - TABLE 20
COST ESTIMATE
ODEM RAW WASTEWATER FACILITIES (COMBINED WITH SINTON & TAFT)
REGIONAL WWTP ALTERNATIVE - OPTION 2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	8" PVC force main	LF	140,200	$11	$1,542,000
2.	Wastewater pump station at WWTP	LS	1	$150,000	$150,000
3.	New wastewater pump station (midway between Odem and Taft)	LS	1	$150,000	$150,000
4.	Peters Swale Crossing	LS	1	$30,000	$30,000
5.	Highway bore, 16" casing (Hwy. 2046, 1074, 631, 893, 181)	LF	880	$200	$176,000
6.	Railroad bore, 16" casing (SPRR)	LF	400	$200	$80,000
7.	16" PVC force main	LF	110,000	$18 (10%)	$198,000
8.	Wastewater Pump Station #3 modifications (located in Taft)	LS	1	$200,000 (10%)	$20,000
9.	Highway bore, 24" casing (Hwy. 631, 136, 35, 181)	LF	1000	$300 (10%)	$30,000
10.	Railroad bore, 24" Casing (SPRR)	LF	300	$300 (10%)	$9,000
11.	Odor control facilities	LS	1	$80,000 (50%)	$40,000

Sub-Total	$2,425,000
Contingency (20%)	$485,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,910,000
Professional Services (13%)	$378,000
Easement/ROW Acquisition	$76,000
TOTAL PROJECT CAPITAL COST	**$3,364,000**

ANNUAL COSTS

Debt Service Sub-Total	$343,000
Operations & Maintenance	$42,000
Power	$16,000
Chemical Addition	$60,000
Sub-Total	$118,000
TOTAL ANNUAL COST	**$461,000**

APPENDIX C - TABLE 21
COST ESTIMATE
2.5 MGD REGIONAL WWTP (ALTERNATIVE R-1)

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	Concrete slabs	CY	500	$200	$100,000
2.	Concrete walls	CY	210	$300	$63,000
3.	Rotary screens	EA	3	$40,000	$120,000
4.	Filter media	CF	18,000	$3	$54,000
5.	Filter distributors	EA	2	$20,000	$40,000
6.	Clarifier equipment	LS	1	$90,000	$90,000
7.	Blowers	EA	2	$5,000	$10,000
8.	Diffusers & piping	LS	1	$10,000	$10,000
9.	Pumps	LS	1	$20,000	$20,000
10.	Sitework	LS	1	$25,000	$25,000
11.	Yard piping	LS	1	$51,000	$51,000
12.	Electrical, instrumentation & controls	LS	1	$51,000	$51,000
13.	Influent pump station	LS	1	$150,000	$150,000
14.	Effluent discharge system	LS	1	$100,000	$100,000
15.	Odor control facilities	LS	1	$150,000	$150,000

Sub-Total	$1,034,000
Contingency (30%)	$310,000
TOTAL ESTIMATED CONSTRUCTION COST	$1,344,000
Professional Services (14%)	$188,000
Property Acquisition	$100,000
TOTAL PROJECT CAPITAL COST	**$1,632,000**

ANNUAL COSTS

Debt Service Sub-Total	$166,000
Operations & Maintenance Labor	$58,000
Power	$48,000
General O & M Supplies	$10,000
Odor Control Facilities	$30,000
Sub-Total	$146,000
TOTAL ANNUAL COST	**$312,000**

APPENDIX C - TABLE 22
COST ESTIMATE
5.0 MGD REGIONAL WWTP - PRIMARY TREATMENT ALTERNATIVE R-1

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	Concrete slabs	CY	1000	$200	$200,000
2.	Concrete walls	CY	420	$300	$126,000
3.	Rotary screens	EA	6	$40,000	$240,000
4.	Filter media	CF	36,000	$3	$108,000
5.	Filter distributors	EA	4	$20,000	$80,000
6.	Clarifier equipment	LS	2	$90,000	$180,000
7.	Blowers	EA	4	$5,000	$20,000
8.	Diffusers & piping	LS	1	$20,000	$20,000
9.	Pumps	LS	1	$40,000	$40,000
10.	Sitework	LS	1	$43,000	$43,000
11.	Yard piping	LS	1	$87,000	$87,000
12.	Electrical, instrumentation & controls	LS	1	$87,000	$87,000
13.	Influent pump station	LS	1	$200,000	$200,000
14.	Effluent discharge system	LS	1	$100,000	$100,000
15.	Odor control facilities	LS	1	$150,000	$150,000

Sub-Total	$1,681,000
Contingency (30%)	$504,000
TOTAL ESTIMATED CONSTRUCTION COST	$2,185,000
Professional Services (13%)	$284,000
Property Acquisition	$100,000
TOTAL PROJECT CAPITAL COST	**$2,569,000**

ANNUAL COSTS

Debt Service Sub-Total	$262,000
Operations & Maintenance Labor	$70,000
Power	$96,000
General O & M Supplies	$20,000
Odor Control Facilities	$40,000
Sub-Total	$226,000
TOTAL ANNUAL COST	**$488,000**

APPENDIX C - TABLE 23
COST ESTIMATE
2.5 MGD REGIONAL WWTP - SECONDARY TREATMENT ALTERNATIVE R-2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	2.5 mgd WWTP	Gal.	2,500,000	$1.25	$3,125,000
2.	Influent pump station	LS	1	$150,000	$150,000
3.	Effluent discharge system	LS	1	$100,000	$100,000
4.	Odor control facilities	LS	1	$150,000	$150,000
		Sub-Total			$3,525,000
		Contingency (20%)			$705,000
		TOTAL ESTIMATED CONSTRUCTION COST			$4,230,000
		Professional Services (13%)			$550,000
		Property Acquisition			$100,000
		TOTAL PROJECT CAPITAL COST			**$4,880,000**
		ANNUAL COSTS			
		Debt Service Sub-Total			$497,000
		Operations & Maintenance			$58,000
		Power			$64,000
		General O & M Supplies			$14,000
		Odor Control Facilities			$30,000
		Sub-Total			$166,000
		TOTAL ANNUAL COST			**$663,000**

APPENDIX C - TABLE 24
COST ESTIMATE
5.0 MGD REGIONAL WWTP - SECONDARY TREATMENT ALTERNATIVE R-2

Item No.	Description	Unit	Approx. Quantity	Unit Price	Total Amount
1.	5.0 mgd WWTP	Gal.	5,000,000	$1.00	$5,000,000
2.	Influent pump station	LS	1	$220,000	$220,000
3.	Effluent discharge system	LS	1	$100,000	$100,000
4.	Odor control facilities	LS	1	$200,000	$200,000
		Sub-Total			$5,520,000
		Contingency (20%)			$1,104,000
		TOTAL ESTIMATED CONSTRUCTION COST			$6,624,000
		Professional Services (12%)			$795,000
		Property Acquisition			$100,000
		TOTAL PROJECT CAPITAL COST			**$7,519,000**
		ANNUAL COSTS			
		Debt Service Sub-Total			$766,000
		Operations & Maintenance			$70,000
		Power			$128,000
		General O & M Supplies			$20,000
		Odor Control Facilities			$40,000
		Sub-Total			$258,000
		TOTAL ANNUAL COST			**$1,024,000**

APPENDIX D

ANNUAL CASH FLOW TABLES

EXISTING SYSTEMS
AND
CONNECTIONS TO REGIONAL SYSTEM
AT VARIOUS DATES
IN THE FUTURE

APPENDIX D - TABLE 1

ANNUAL CASH FLOW – OPTION 1
PORTLAND - EXISTING WWTP

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D UV Debt Service/ O & M (Note 2)	E Plant Upgrade Debt Service (Note 3)	F Maint. Reserve (Note 4)	G Total Annual Cost (Note 5)
1. 1994-95	$161	$269	$51	-	$27	**$508**
2. 1995-96	161	269	51	-	27	**508**
3. 1996-97	161	269	51	-	27	**508**
4. 1997-98	161	269	51	-	27	**508**
5. 1998-99	161	269	51	$25	27	**533**
6. 1999-2000	161	269	51	25	27	**533**
7. 2000-01	-	269	51	25	27	**372**
8. 2001-02	-	269	51	25	27	**372**
9. 2002-03	-	269	51	25	27	**372**
10. 2003-04	-	269	51	25	27	**372**
11. 2004-05	-	269	51	25	27	**372**
12. 2005-06	-	269	51	25	-	**345**
13. 20006-07	-	269	51	25	-	**345**
14. 2006-07	-	269	51	25	-	**345**
15. 2008-09	-	269	51	25	-	**345**
16. 2009-10	-	269	51	25	-	**345**
17. 2010-11	-	269	51	25	-	**345**
18. 2011-12	-	269	51	25	-	**345**
19. 1012-13	-	269	51	25	-	**345**
20. 2013-14	-	269	51	25	-	**345**
21. 2014-15	-	269	10	25	-	**304**
22. 2015-16	-	269	10	25	-	**304**
23. 2016-17	-	269	10	25	-	**304**
24. 2017-18	-	269	10	25	-	**304**
25. 2018-19	-	269	10	-	-	**279**
26. 2019-2020	-	269	10	-	-	**279**

APPENDIX D - TABLE 2

ANNUAL CASH FLOW -- OPTION 1
PORTLAND - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1997

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Existing O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Charges, Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$161	$269	-	-	-	$508	-
2. 1995-96	161	269	-	-	-	508	-
3. 1996-97	161	269	-	-	-	508	-
4. 1997-98	161	-	$170	$119	$241	508	$183
5. 1998-99	161	-	170	119	266	533	183
6. 1999-2000	161	-	170	119	266	533	183
7. 2001-01	-	-	170	119	266	372	183
8. 2001-02	-	-	170	119	266	372	183
9. 2002-03	-	-	170	119	266	372	183
10. 2003-04	-	-	170	119	266	372	183
11. 2004-05	-	-	170	119	266	372	183
12. 2005-06	-	-	170	119	239	345	183
13. 2006-07	-	-	170	119	239	345	183
14. 2007-08	-	-	170	119	239	345	183
15. 2008-09	-	-	170	119	239	345	183
16. 2009-10	-	-	170	119	239	345	183
17. 2010-11	-	-	170	119	239	345	183
18. 2011-12	-	-	170	119	239	345	183
19. 2012-13	-	-	170	119	239	345	183
20. 2013-14	-	-	170	119	239	345	183
21. 2014-15	-	-	170	119	198	304	183
22. 2015-16	-	-	170	119	198	304	183
23. 2016-17	-	-	170	119	198	304	183
24. 2017-18	-	-	-	119	368	304	183
25. 2018-19	-	-	-	119	343	279	183
26. 2019-2020	-	-	-	119	343	279	183

APPENDIX D - TABLE 3

ANNUAL CASH FLOW – OPTION 1
PORTLAND - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2000

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F UV Debt Service & O & M (Note 3)	G Regional WWTP Debt Service & O & M (Note 4)	H Total Annual Cost (Note 5)	I Value of Effluent (Note 6)
1. 1994-95	$161	$269	-	-	$51	-	$508	-
2. 1995-96	161	269	-	-	51	-	508	-
3. 1996-97	161	269	-	-	51	-	508	-
4. 1997-98	161	269	-	-	51	-	508	-
5. 1998-99	161	269	-	-	51	-	533	-
6. 1999-2000	161	269	-	-	51	-	533	-
7. 2000-01	-	-	$170	$119	41	$225	372	$183
8. 2001-02	-	-	170	119	41	225	372	183
9. 2002-03	-	-	170	119	41	225	372	183
10. 2003-04	-	-	170	119	41	225	372	183
11. 2004-05	-	-	170	119	41	225	372	183
12. 2005-06	-	-	170	119	41	198	345	183
13. 2006-07	-	-	170	119	41	198	345	183
14. 2007-08	-	-	170	119	41	198	345	183
15. 2008-09	-	-	170	119	41	198	345	183
16. 2009-10	-	-	170	119	41	198	345	183
17. 2010-11	-	-	170	119	41	198	345	183
18. 2011-12	-	-	170	119	41	198	345	183
19. 2012-13	-	-	170	119	41	198	345	183
20. 2013-14	-	-	170	119	41	198	345	183
21. 2014-15	-	-	170	119	-	198	304	183
22. 2015-16	-	-	170	119	-	198	304	183
23. 2016-17	-	-	170	119	-	198	304	183
24. 2017-18	-	-	170	119	-	198	304	183
25. 2018-19	-	-	170	119	-	173	279	183
26. 2019-2020	-	-	170	119	-	173	279	183

APPENDIX D

PORTLAND
ANNUAL CASH FLOW TABLES

TABLE 1 NOTES:

1. Annual debt service and annual O & M costs provided by City of Portland.

2. Assumes capital cost of $400,000 @ 8% for 20 yrs = $41,000/yr + $10,000/yr O & M cost reguired for installation of UV disinfection system to meet TNRCC requirements. (Based on previous estimate to City of Portland by NEI, dated September, 1992.

3. Assumes plant upgrade cost of $250,000 @ 8% for 20 yrs = $25,000/yr to meet more stringent effluent limitations required at permit renewal (Based on $0.10/gallon X 2.5 mgd).

4. Assumes annual maintenance reserve through year 2004 to fund estimated equipment replacement cost of $300,000 at end of 20 year equipment life ($300,000 ÷ 11 years = $27,000/yr)

5. Total annual cost = (column B+C+D+E+F)

TABLE 2 NOTES:

1. Annual debt service and O & M costs provided by City of Portland.

2. Annual debt service and O & M costs from Appendix C - Table 1.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B - Table 1.

5. Value of effluent from Table 2-18.

TABLE 3 NOTES:

1. Annual debt service and O & M costs provided by City of Portland.

2. Annual debt service and O & M cost from Appendix C - Table 2.

3. Assumes capital cost of $400,000 @ 8% for 20 yrs = $41,000/yr + $10,000/yr O & M cost required for installation of UV disinfection system to meet TNRCC requirements. (Based on previous estimate to City of Portland by NEI, dated September, 1992).

4. Amount available for Regional WWTP debt service and O & M costs = (columns H+I) - (columns B+C+D+E+F).

5. Total annual cost from Appendix B - Table 1.

6. Value of effluent from Table 2-18.

APPENDIX D - TABLE 4

ANNUAL CASH FLOW -- OPTION 1
GREGORY - EXISTING WWTP

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D Maintenance Reserve (Note 2)	E Total Annual Cost (Note 3)
1. 1994-95	$25	$102	$9	$136
2. 1995-96	25	102	9	136
3. 1996-97	25	102	9	136
4. 1997-98	25	102	9	136
5. 1998-99	25	102	9	136
6. 1999-2000	25	102	9	136
7. 2000-01	25	102	9	136
8. 2001-02	25	102	9	136
9. 2002-03	-	102	-	102
10. 2003-04	-	102	-	102
11. 2004-05	-	102	-	102
12. 2005-06	-	102	-	102
13. 20006-07	-	102	-	102
14. 2006-07	-	102	-	102
15. 2008-09	-	102	-	102
16. 2009-10	-	102	-	102
17. 2010-11	-	102	-	102
18. 2011-12	-	102	-	102
19. 1012-13	-	102	-	102
20. 2013-14	-	102	-	102
21. 2014-15	-	102	-	102
22. 2015-16	-	102	-	102
23. 2016-17	-	102	-	102
24. 2017-18	-	102	-	102
25. 2018-19	-	102	-	102
26. 2019-2020	-	102	-	102

APPENDIX D - TABLE 5

ANNUAL CASH FLOW -- OPTION 1
GREGORY - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1997

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Charges, Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$25	$102	-	-	-	$136	-
2. 1995-96	25	102	-	-	-	136	-
3. 1996-97	25	102	-	-	-	136	-
4. 1997-98	25	-	$55	$48	$43	136	$35
5. 1998-99	25	-	55	48	43	136	35
6. 1999-2000	25	-	55	48	43	136	35
7. 2001-01	25	-	55	48	43	136	35
8. 2001-02	25	-	55	48	43	136	35
9. 2002-03	-	-	55	48	34	102	35
10. 2003-04	-	-	55	48	34	102	35
11. 2004-05	-	-	55	48	34	102	35
12. 2005-06	-	-	55	48	34	102	35
13. 2006-07	-	-	55	48	34	102	35
14. 2007-08	-	-	55	48	34	102	35
15. 2008-09	-	-	55	48	34	102	35
16. 2009-10	-	-	55	48	34	102	35
17. 2010-11	-	-	55	48	34	102	35
18. 2011-12	-	-	55	48	34	102	35
19. 2012-13	-	-	55	48	34	102	35
20. 2013-14	-	-	55	48	34	102	35
21. 2014-15	-	-	55	48	34	102	35
22. 2015-16	-	-	55	48	34	102	35
23. 2016-17	-	-	55	48	34	102	35
24. 2017-18	-	-	-	48	89	102	35
25. 2018-19	-	-	-	48	89	102	35
26. 2019-2020	-	-	-	48	89	102	35

APPENDIX D - TABLE 6

ANNUAL CASH FLOW -- OPTION 1
GREGORY - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2002

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Charges, Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$25	$102	-	-	-	$136	-
2. 1995-96	25	102	-	-	-	136	-
3. 1996-97	25	102	-	-	-	136	-
4. 1997-98	25	102	-	-	-	136	-
5. 1998-99	25	102	-	-	-	136	-
6. 1999-2000	25	102	-	-	-	136	-
7. 2001-01	25	102	-	-	-	136	-
8. 2001-02	25	102	-	-	-	136	-
9. 2002-03	-	-	$55	$48	$34	102	$35
10. 2003-04	-	-	55	48	34	102	35
11. 2004-05	-	-	55	48	34	102	35
12. 2005-06	-	-	55	48	34	102	35
13. 2006-07	-	-	55	48	34	102	35
14. 2007-08	-	-	55	48	34	102	35
15. 2008-09	-	-	55	48	34	102	35
16. 2009-10	-	-	55	48	34	102	35
17. 2010-11	-	-	55	48	34	102	35
18. 2011-12	-	-	55	48	34	102	35
19. 2012-13	-	-	55	48	34	102	35
20. 2013-14	-	-	55	48	34	102	35
21. 2014-15	-	-	55	48	34	102	35
22. 2015-16	-	-	55	48	34	102	35
23. 2016-17	-	-	55	48	34	102	35
24. 2017-18	-	-	55	48	34	102	35
25. 2018-19	-	-	55	48	34	102	35
26. 2019-2020	-	-	55	48	34	102	35

APPENDIX D

GREGORY
ANNUAL CASH FLOW TABLES

TABLE 4 NOTES:

1. Annual debt service and O & M costs provided by City of Gregory.

2. Assumes annual maintenance reserve through year 2001 to fund estimated equipment replacement cost of $72,000 at end of 20-year equipment life. $72,000 ÷ 8 yrs = $9,000/yr.

3. Total annual cost = (columns B+C+D).

TABLE 5 NOTES:

1. Existing debt service and annual O & M costs provided by City of Gregory.

2. Annual debt service and O & M cost from Appendix C - Table 3.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B - Table 2.

5. Value of effluent from Table 2-18.

TABLE 6 NOTES:

1. Existing debt service and annual O & M costs provided by City of Gregory.

2. Annual debt service and O & M cost from Appendix C - Table 4.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B-2.

5. Value of effluent from Table 2-18.

APPENDIX D - TABLE 7

ANNUAL CASH FLOW -- OPTION 1
ARANSAS PASS - EXISTING WWTP

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D UV Debt Service/ O & M (Note 2)	E Plant Upgrade Debt Service (Note 3)	F Maint. Reserve for Future Equipment Replacement (Note 4)	G Aeration/Sludge Basin Improvements Debt Service (Note 5)	H Total Annual Cost (Note 6)
1. 1994-95	$206	$269	$59	$16	$38	$39	$627
2. 1995-96	206	269	59	16	38	39	627
3. 1996-97	206	269	59	16	38	39	627
4. 1997-98	206	269	59	16	38	39	627
5. 1998-99	206	269	59	16	38	39	627
6. 1999-2000	103	269	59	16	38	39	524
7. 2001-01	-	269	59	16	38	39	421
8. 2001-02	-	269	59	16	38	39	421
9. 2002-03	-	269	59	16	-	39	383
10. 2003-04	-	269	59	16	-	39	383
11. 2004-05	-	269	59	16	-	39	383
12. 2005-06	-	269	59	16	-	39	383
13. 2006-07	-	269	59	16	-	39	383
14. 2007-08	-	269	59	16	-	39	383
15. 2008-09	-	269	59	16	-	39	383
16. 2009-10	-	269	59	16	-	39	383
17. 2010-11	-	269	59	16	-	39	383
18. 2011-12	-	269	59	16	-	39	383
19. 2012-13	-	269	59	16	-	39	383
20. 2013-14	-	269	59	16	-	39	383
21. 2014-15	-	269	12	-	-	-	281
22. 2015-16	-	269	12	-	-	-	281
23. 2016-17	-	269	12	-	-	-	281
24. 2017-18	-	269	12	-	-	-	281
25. 2018-19	-	269	12	-	-	-	281
26. 2019-2020	-	269	12	-	-	-	281

APPENDIX D - TABLE 8

ANNUAL CASH FLOW -- OPTION 1
ARANSAS PASS - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1997

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Existing O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$206	$269	-	-	-	$627	-
2. 1995-96	206	269	-	-	-	627	-
3. 1996-97	206	269	-	-	-	627	-
4. 1997-98	206	-	$289	$236	$32	627	$136
5. 1998-99	206	-	289	236	32	627	136
6. 1999-2000	103	-	289	236	32	524	136
7. 2001-01	-	-	289	236	32	421	136
8. 2001-02	-	-	289	236	32	421	136
9. 2002-03	-	-	289	236	(-6)	383	136
10. 2003-04	-	-	289	236	(-6)	383	136
11. 2004-05	-	-	289	236	(-6)	383	136
12. 2005-06	-	-	289	236	(-6)	383	136
13. 2006-07	-	-	289	236	(-6)	383	136
14. 2007-08	-	-	289	236	(-6)	383	136
15. 2008-09	-	-	289	236	(-6)	383	136
16. 2009-10	-	-	289	236	(-6)	383	136
17. 2010-11	-	-	289	236	(-6)	383	136
18. 2011-12	-	-	289	236	(-6)	383	136
19. 2012-13	-	-	289	236	(-6)	383	136
20. 2013-14	-	-	289	236	(-6)	383	136
21. 2014-15	-	-	289	236	(-108)	281	136
22. 2015-16	-	-	289	236	(-108)	281	136
23. 2016-17	-	-	289	236	(-108)	281	136
24. 2017-18	-	-	-	236	181	281	136
25. 2018-19	-	-	-	236	181	281	136
26. 2019-2020	-	-	-	236	181	281	136

APPENDIX D - TABLE 9

ANNUAL CASH FLOW -- OPTION 1
ARANSAS PASS - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2000

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F UV & Plant Rehab Costs (Note 3)	G Regional WWTP Debt Service & O & M (Note 4)	H Total Annual Cost (Note 5)	I Value of Effluent (Note 6)
1. 1994-95	$161	$269	-	-	$55	-	$627	-
2. 1995-96	161	269	-	-	55	-	627	-
3. 1996-97	161	269	-	-	55	-	627	-
4. 1997-98	161	269	-	-	55	-	627	-
5. 1998-99	161	269	-	-	55	-	627	-
6. 1999-2000	161	269	-	-	55	-	524	-
7. 2000-01	-	-	$289	$236	55	$(-23)	421	$136
8. 2001-02	-	-	289	236	55	(-23)	421	136
9. 2002-03	-	-	289	236	55	(-61)	383	136
10. 2003-04	-	-	289	236	55	(-61)	383	136
11. 2004-05	-	-	289	236	55	(-61)	383	136
12. 2005-06	-	-	289	236	55	(-61)	383	136
13. 2006-07	-	-	289	236	55	(-61)	383	136
14. 2007-08	-	-	289	236	55	(-61)	383	136
15. 2008-09	-	-	289	236	55	(-61)	383	136
16. 2009-10	-	-	289	236	55	(-61)	383	136
17. 2010-11	-	-	289	236	55	(-61)	383	136
18. 2011-12	-	-	289	236	55	(-61)	383	136
19. 2012-13	-	-	289	236	55	(-61)	383	136
20. 2013-14	-	-	289	236	55	(-61)	383	136
21. 2014-15	-	-	289	236	-	(-108)	281	136
22. 2015-16	-	-	289	236	-	(-108)	281	136
23. 2016-17	-	-	289	236	-	(-108)	281	136
24. 2017-18	-	-	289	236	-	(-108)	281	136
25. 2018-19	-	-	289	236	-	(-108)	281	136
26. 2019-2020	-	-	289	236	-	(-108)	281	136

APPENDIX D

ARANSAS PASS
ANNUAL CASH FLOW TABLES

TABLE 7 NOTES:

1. Annual debt service and O & M cost provided by City of Aransas Pass.

2. Assumes capital cost of $466,000 @ 8% for 20 yrs = $47,000/yr + $12,000/yr O & M cost required for installation of UV disinfection system to meet TNRCC requirements. (Based on previous estimate to city of Aransas Pass by NEI, dated August, 1993).

3. Assumes plant upgrade cost of $160,000 @ 8% for 20 yrs = $16,000/yr to meet more stringent effluent limitations required at permit renewal (Based on $0.10/gallon X 1.6 mgd).

4. Assumes annual maintenance reserve through year 2001 to fund estimated equipment replacement cost of $300,000 at end of 20-year equipment life ($300,000 ÷ 8 yrs = $38,000/yr)

5. Assumes capital cost of $385,000 @ 8% for 20 yrs = $39,000/yr for aeration basin and sludge basin improvements (Based on previous estimate to City of Aransas Pass by NEI, dated August, 1993).

6. Total annual cost = (columns B+C+D+E+F+G).

TABLE 8 NOTES:

1. Annual debt service and O & M costs provided by City of Aransas Pass.

2. Annual debt service and O & M costs from Appendix C - Table 5.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B - Table 3.

5. Value of effluent from Table 2-18.

TABLE 9 NOTES:

1. Annual debt service and O & M cost provided by City of Aransas Pass.

2. Annual debt service and O & M cost from Appendix C - Table 6.

3. Assumes capital cost of $466,000 @ 8% for 20 yrs = $47,000/yr + $12,000/yr O & M cost required for installation of UV disinfection system to meet TNRCC requirements. Assumes capital cost of $385,000 @ 8% for 20 yrs = $39,000/yr for aeration basin and sludge basin improvements. (Based on previous estimate to City of Aransas Pass by NEI, dated August, 1993.) Assumes plant upgrade cost of $160,000 @ 8% for 20 yrs = $16,000/yr to meet more stringent effluent limitations required at permit renewal (Based on $0.10/gallon X 1.6 mgd).

4. Amount available for Regional WWTP debt service and O & M costs = (columns H+I) - (columns B+C+D+E+F).

5. Total annual cost from Appendix B - Table 3.

6. Value of effluent from Table 2-18.

APPENDIX D - TABLE 10

ANNUAL CASH FLOW -- OPTION 1
INGLESIDE - EXISTING WWTP

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D Maintenance Reserve for Future Equipment Replacement (Note 2)	E Total Annual Cost (Note 3)
1. 1994-95	$18	$191	$18	$227
2. 1995-96	18	191	18	227
3. 1996-97	19	191	18	228
4. 1997-98	19	191	18	228
5. 1998-99	18	191	18	227
6. 1999-2000	19	191	18	228
7. 2000-01	19	191	18	228
8. 2001-02	18	191	18	227
9. 2002-03	56	191	18	265
10. 2003-04	62	191	18	271
11. 2004-05	58	191	18	267
12. 2005-06	-	191	-	191
13. 20006-07	-	191	-	191
14. 2006-07	-	191	-	191
15. 2008-09	-	191	-	191
16. 2009-10	-	191	-	191
17. 2010-11	-	191	-	191
18. 2011-12	-	191	-	191
19. 1012-13	-	191	-	191
20. 2013-14	-	191	-	191
21. 2014-15	-	191	-	191
22. 2015-16	-	191	-	191
23. 2016-17	-	191	-	191
24. 2017-18	-	191	-	191
25. 2018-19	-	191	-	191
26. 2019-2020	-	191	-	191

APPENDIX D - TABLE 11

ANNUAL CASH FLOW -- OPTION 1
INGLESIDE - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1997

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Charges, Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$18	$191	-	-	-	$227	-
2. 1995-96	18	191	-	-	-	227	-
3. 1996-97	19	191	-	-	-	228	-
4. 1997-98	19	-	$180	$150	(-52)	228	$69
5. 1998-99	18	-	180	150	(-52)	227	69
6. 1999-2000	19	-	180	150	(-52)	228	69
7. 2001-01	19	-	180	150	(-52)	228	69
8. 2001-02	18	-	180	150	(-52)	227	69
9. 2002-03	56	-	180	150	(-52)	265	69
10. 2003-04	62	-	180	150	(-52)	271	69
11. 2004-05	58	-	180	150	(-52)	267	69
12. 2005-06	-	-	180	150	(-70)	191	69
13. 2006-07	-	-	180	150	(-70)	191	69
14. 2007-08	-	-	180	150	(-70)	191	69
15. 2008-09	-	-	180	150	(-70)	191	69
16. 2009-10	-	-	180	150	(-70)	191	69
17. 2010-11	-	-	180	150	(-70)	191	69
18. 2011-12	-	-	180	150	(-70)	191	69
19. 2012-13	-	-	180	150	(-70)	191	69
20. 2013-14	-	-	180	150	(-70)	191	69
21. 2014-15	-	-	180	150	(-70)	191	69
22. 2015-16	-	-	180	150	(-70)	191	69
23. 2016-17	-	-	180	150	(-70)	191	69
24. 2017-18	-	-	180	150	(-70)	191	69
25. 2018-19	-	-	180	150	(-70)	191	69
26. 2019-2020	-	-	180	150	(-70)	191	69

APPENDIX D - TABLE 12

ANNUAL CASH FLOW -- OPTION 1
INGLESIDE - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2005

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$18	$191	-	-	-	$227	-
2. 1995-96	18	191	-	-	-	227	-
3. 1996-97	19	191	-	-	-	228	-
4. 1997-98	19	191	-	-	-	228	-
5. 1998-99	18	191	-	-	-	227	-
6. 1999-2000	19	191	-	-	-	228	-
7. 2001-01	19	191	-	-	-	228	-
8. 2001-02	18	191	-	-	-	227	-
9. 2002-03	56	191	-	-	-	265	-
10. 2003-04	62	191	-	-	-	271	-
11. 2004-05	58	191	-	-	-	267	-
12. 2005-06	-	-	$180	$150	(-70)	191	$69
13. 2006-07	-	-	180	150	(-70)	191	69
14. 2007-08	-	-	180	150	(-70)	191	69
15. 2008-09	-	-	180	150	(-70)	191	69
16. 2009-10	-	-	180	150	(-70)	191	69
17. 2010-11	-	-	180	150	(-70)	191	69
18. 2011-12	-	-	180	150	(-70)	191	69
19. 2012-13	-	-	180	150	(-70)	191	69
20. 2013-14	-	-	180	150	(-70)	191	69
21. 2014-15	-	-	180	150	(-70)	191	69
22. 2015-16	-	-	180	150	(-70)	191	69
23. 2016-17	-	-	180	150	(-70)	191	69
24. 2017-18	-	-	180	150	(-70)	191	69
25. 2018-19	-	-	180	150	(-70)	191	69
26. 2019-2020	-	-	180	150	(-70)	191	69

APPENDIX D

INGLESIDE
ANNUAL CASH FLOW TABLES

TABLE 10 NOTES:

1. Annual debt service and O & M costs provided by City of Ingleside.

2. Assumes annual maintenance reserve through year 2004 to fund estimated equipment replacement cost of \$200,000 at end of 20-year equipment life. (\$200,000 ÷ 11 years = \$18,000/yr).

3. Total annual cost = (columns B+C+D).

TABLE 11 & 14 NOTES:

1. Annual debt service and O & M costs provided by City of Ingleside.

2. Annual debt service and O & M cost from Appendix C - Table 7.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E+F).

4. Total annual cost from Appendix B - Table 4.

5. Value of effluent from Table 2-18.

TABLE 12 & 17 NOTES:

1. Annual debt service and O & M costs provided by City of Ingleside.

2. Annual debt service and O & M costs from Appendix C - Table 8.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - columns B+C+D+E+F).

4. Total annual cost from Appendix B - Table 4.

5. Value of effluent from Table 2-18.

APPENDIX D - TABLE 13

ANNUAL CASH FLOW - OPTION 1
ARANSAS PASS - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1997
COMBINED WITH INGLESIDE

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Existing O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$206	$269	-	-	-	$627	-
2. 1995-96	206	269	-	-	-	627	-
3. 1996-97	206	269	-	-	-	627	-
4. 1997-98	206	-	$272	$202	$83	627	$136
5. 1998-99	206	-	272	202	83	627	136
6. 1999-2000	103	-	272	202	83	524	136
7. 2001-01	-	-	272	202	83	421	136
8. 2001-02	-	-	272	202	83	421	136
9. 2002-03	-	-	272	202	45	383	136
10. 2003-04	-	-	272	202	45	383	136
11. 2004-05	-	-	272	202	45	383	136
12. 2005-06	-	-	272	202	45	383	136
13. 2006-07	-	-	272	202	45	383	136
14. 2007-08	-	-	272	202	45	383	136
15. 2008-09	-	-	272	202	45	383	136
16. 2009-10	-	-	272	202	45	383	136
17. 2010-11	-	-	272	202	45	383	136
18. 2011-12	-	-	272	202	45	383	136
19. 2012-13	-	-	272	202	45	383	136
20. 2013-14	-	-	272	202	45	383	136
21. 2014-15	-	-	272	202	(-57)	281	136
22. 2015-16	-	-	272	202	(-57)	281	136
23. 2016-17	-	-	272	202	(-57)	281	136
24. 2017-18	-	-	-	202	215	281	136
25. 2018-19	-	-	-	202	215	281	136
26. 2019-2020	-	-	-	202	215	281	136

APPENDIX D - TABLE 14

ANNUAL CASH FLOW -- OPTION 1
INGLESIDE - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1997
COMBINED WITH ARANSAS PASS

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Charges, Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$18	$191	-	-	-	$227	-
2. 1995-96	18	191	-	-	-	227	-
3. 1996-97	19	191	-	-	-	228	-
4. 1997-98	19	-	$128	$99	$51	228	$69
5. 1998-99	18	-	128	99	51	227	69
6. 1999-2000	19	-	128	99	51	228	69
7. 2001-01	19	-	128	99	51	228	69
8. 2001-02	18	-	128	99	51	227	69
9. 2002-03	56	-	128	99	51	265	69
10. 2003-04	62	-	128	99	51	271	69
11. 2004-05	58	-	128	99	51	267	69
12. 2005-06	-	-	128	99	33	191	69
13. 2006-07	-	-	128	99	33	191	69
14. 2007-08	-	-	128	99	33	191	69
15. 2008-09	-	-	128	99	33	191	69
16. 2009-10	-	-	128	99	33	191	69
17. 2010-11	-	-	128	99	33	191	69
18. 2011-12	-	-	128	99	33	191	69
19. 2012-13	-	-	128	99	33	191	69
20. 2013-14	-	-	128	99	33	191	69
21. 2014-15	-	-	128	99	33	191	69
22. 2015-16	-	-	128	99	33	191	69
23. 2016-17	-	-	128	99	33	191	69
24. 2017-18	-	-	128	99	33	191	69
25. 2018-19	-	-	128	99	33	191	69
26. 2019-2020	-	-	128	99	33	191	69

APPENDIX D - TABLE 15

ANNUAL CASH FLOW – OPTION 1
ARANSAS PASS - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2000

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F UV & Plant Rehab Costs (Note 3)	G Regional WWTP Debt Service & O & M (Note 4)	H Total Annual Cost (Note 5)	I Value of Effluent (Note 6)
1. 1994-95	$161	$269	-	-	$55	-	$627	-
2. 1995-96	161	269	-	-	55	-	627	-
3. 1996-97	161	269	-	-	55	-	627	-
4. 1997-98	161	269	-	-	55	-	627	-
5. 1998-99	161	269	-	-	55	-	627	-
6. 1999-2000	161	269	-	-	55	-	524	-
7. 2000-01	-	-	$289	$236	55	$(-23)	421	$136
8. 2001-02	-	-	289	236	55	(-23)	421	136
9. 2002-03	-	-	289	236	55	(-61)	383	136
10. 2003-04	-	-	289	236	55	(-61)	383	136
11. 2004-05	-	-	289	236	55	(-61)	383	136
12. 2005-06	-	-	289	236	55	(-61)	383	136
13. 2006-07	-	-	289	236	55	(-61)	383	136
14. 2007-08	-	-	289	236	55	(-61)	383	136
15. 2008-09	-	-	289	236	55	(-61)	383	136
16. 2009-10	-	-	289	236	55	(-61)	383	136
17. 2010-11	-	-	289	236	55	(-61)	383	136
18. 2011-12	-	-	289	236	55	(-61)	383	136
19. 2012-13	-	-	289	236	55	(-61)	383	136
20. 2013-14	-	-	289	236	55	(-61)	383	136
21. 2014-15	-	-	289	236	-	(-108)	281	136
22. 2015-16	-	-	289	236	-	(-108)	281	136
23. 2016-17	-	-	289	236	-	(-108)	281	136
24. 2017-18	-	-	289	236	-	(-108)	281	136
25. 2018-19	-	-	289	236	-	(-108)	281	136
26. 2019-2020	-	-	289	236	-	(-108)	281	136

APPENDIX D - TABLE 16

ANNUAL CASH FLOW -- OPTION 1
ARANSAS PASS - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2000
COMBINED WITH INGLESIDE

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F UV & Plant Rehab Costs (Note 3)	G Regional WWTP Debt Service & O & M (Note 4)	H Total Annual Cost (Note 5)	I Value of Effluent (Note 6)
1. 1994-95	$206	$269	-	-	$114	-	$627	-
2. 1995-96	206	269	-	-	114	-	627	-
3. 1996-97	206	269	-	-	114	-	627	-
4. 1997-98	206	269	-	-	114	-	627	-
5. 1998-99	206	269	-	-	114	-	627	-
6. 1999-2000	103	269	-	-	114	-	524	-
7. 2000-01	-	-	$269	$202	114	(-28)	421	$136
8. 2001-02	-	-	269	202	114	(-28)	421	136
9. 2002-03	-	-	269	202	114	(-66)	383	136
10. 2003-04	-	-	269	202	114	(-66)	383	136
11. 2004-05	-	-	269	202	114	(-66)	383	136
12. 2005-06	-	-	269	202	114	(-66)	383	136
13. 2006-07	-	-	269	202	114	(-66)	383	136
14. 2007-08	-	-	269	202	114	(-66)	383	136
15. 2008-09	-	-	269	202	114	(-66)	383	136
16. 2009-10	-	-	269	202	114	(-66)	383	136
17. 2010-11	-	-	269	202	114	(-66)	383	136
18. 2011-12	-	-	269	202	114	(-66)	383	136
19. 2012-13	-	-	269	202	114	(-66)	383	136
20. 2013-14	-	-	269	202	114	(-66)	383	136
21. 2014-15	-	-	269	202	-	(-54)	281	136
22. 2015-16	-	-	269	202	-	(-54)	281	136
23. 2016-17	-	-	269	202	-	(-54)	281	136
24. 2017-18	-	-	269	202	-	(-54)	281	136
25. 2018-19	-	-	269	202	-	(-54)	281	136
26. 2019-2020	-	-	269	202	-	(-54)	281	136

APPENDIX D - TABLE 17

ANNUAL CASH FLOW -- OPTION 1
INGLESIDE - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 2005
COMBINED WITH ARANSAS PASS

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$18	$191	-	-	-	$227	-
2. 1995-96	18	191	-	-	-	227	-
3. 1996-97	19	191	-	-	-	228	-
4. 1997-98	19	191	-	-	-	228	-
5. 1998-99	18	191	-	-	-	227	-
6. 1999-2000	19	191	-	-	-	228	-
7. 2001-01	19	191	-	-	-	228	-
8. 2001-02	18	191	-	-	-	227	-
9. 2002-03	56	191	-	-	-	265	-
10. 2003-04	62	191	-	-	-	271	-
11. 2004-05	58	191	-	-	-	267	-
12. 2005-06	-	-	$128	$99	$33	$191	$69
13. 2006-07	-	-	128	99	33	191	69
14. 2007-08	-	-	128	99	33	191	69
15. 2008-09	-	-	128	99	33	191	69
16. 2009-10	-	-	128	99	33	191	69
17. 2010-11	-	-	128	99	33	191	69
18. 2011-12	-	-	128	99	33	191	69
19. 2012-13	-	-	128	99	33	191	69
20. 2013-14	-	-	128	99	33	191	69
21. 2014-15	-	-	128	99	33	191	69
22. 2015-16	-	-	128	99	33	191	69
23. 2016-17	-	-	128	99	33	191	69
24. 2017-18	-	-	128	99	33	191	69
25. 2018-19	-	-	128	99	33	191	69
26. 2019-2020	-	-	128	99	33	191	69

APPENDIX D - TABLE 18

ANNUAL CASH FLOW -- OPTION 1
TAFT - EXISTING WWTP

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D Maintenance Reserve for Future Equipment Replacement (Note 2)	E Total Annual Cost (Note 3)
1. 1994-95	$81	$102	$22	$205
2. 1995-96	81	102	22	205
3. 1996-97	81	102	22	205
4. 1997-98	81	102	22	205
5. 1998-99	-	102	22	124
6. 1999-2000	-	102	22	124
7. 2000-01	-	102	22	124
8. 2001-02	-	102	22	124
9. 2002-03	-	102	22	124
10. 2003-04	-	102	-	102
11. 2004-05	-	102	-	102
12. 2005-06	-	102	-	102
13. 20006-07	-	102	-	102
14. 2006-07	-	102	-	102
15. 2008-09	-	102	-	102
16. 2009-10	-	102	-	102
17. 2010-11	-	102	-	102
18. 2011-12	-	102	-	102
19. 1012-13	-	102	-	102
20. 2013-14	-	102	-	102
21. 2014-15	-	102	-	102
22. 2015-16	-	102	-	102
23. 2016-17	-	102	-	102
24. 2017-18	-	102	-	102
25. 2018-19	-	102	-	102
26. 2019-2020	-	102	-	102

APPENDIX D - TABLE 19

ANNUAL CASH FLOW -- OPTION 1
TAFT - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1998

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$81	$102	-	-	-	$205	-
2. 1995-96	81	102	-	-	-	205	-
3. 1996-97	81	102	-	-	-	205	-
4. 1997-98	81	102	-	-	-	205	-
5. 1998-99	-	-	$178	$98	(-76)	124	$76
6. 1999-2000	-	-	178	98	(-76)	124	76
7. 2001-01	-	-	178	98	(-76)	124	76
8. 2001-02	-	-	178	98	(-76)	124	76
9. 2002-03	-	-	178	98	(-76)	124	76
10. 2003-04	-	-	178	98	(-98)	102	76
11. 2004-05	-	-	178	98	(-98)	102	76
12. 2005-06	-	-	178	98	(-98)	102	76
13. 2006-07	-	-	178	98	(-98)	102	76
14. 2007-08	-	-	178	98	(-98)	102	76
15. 2008-09	-	-	178	98	(-98)	102	76
16. 2009-10	-	-	178	98	(-98)	102	76
17. 2010-11	-	-	178	98	(-98)	102	76
18. 2011-12	-	-	178	98	(-98)	102	76
19. 2012-13	-	-	178	98	(-98)	102	76
20. 2013-14	-	-	178	98	(-98)	102	76
21. 2014-15	-	-	178	98	(-98)	102	76
22. 2015-16	-	-	178	98	(-98)	102	76
23. 2016-17	-	-	178	98	(-98)	102	76
24. 2017-18	-	-	178	98	(-98)	102	76
25. 2018-19	-	-	-	98	80	102	76
26. 2019-2020	-	-	-	98	80	102	76

APPENDIX D - TABLE 20

ANNUAL CASH FLOW -- OPTION 1
TAFT - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1998
COMBINED WITH SINTON

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$81	$102	-	-	-	$205	-
2. 1995-96	81	102	-	-	-	205	-
3. 1996-97	81	102	-	-	-	205	-
4. 1997-98	81	102	-	-	-	205	-
5. 1998-99	-	-	$121	$60	$19	124	$76
6. 1999-2000	-	-	121	60	19	124	76
7. 2001-01	-	-	121	60	19	124	76
8. 2001-02	-	-	121	60	19	124	76
9. 2002-03	-	-	121	60	19	124	76
10. 2003-04	-	-	121	60	(-3)	102	76
11. 2004-05	-	-	121	60	(-3)	102	76
12. 2005-06	-	-	121	60	(-3)	102	76
13. 2006-07	-	-	121	60	(-3)	102	76
14. 2007-08	-	-	121	60	(-3)	102	76
15. 2008-09	-	-	121	60	(-3)	102	76
16. 2009-10	-	-	121	60	(-3)	102	76
17. 2010-11	-	-	121	60	(-3)	102	76
18. 2011-12	-	-	121	60	(-3)	102	76
19. 2012-13	-	-	121	60	(-3)	102	76
20. 2013-14	-	-	121	60	(-3)	102	76
21. 2014-15	-	-	121	60	(-3)	102	76
22. 2015-16	-	-	121	60	(-3)	102	76
23. 2016-17	-	-	121	60	(-3)	102	76
24. 2017-18	-	-	121	60	(-3)	102	76
25. 2018-19	-	-	-	60	118	102	76
26. 2019-2020	-	-	-	60	118	102	76

APPENDIX D

TAFT
ANNUAL CASH FLOW TABLES

TABLE 18 NOTES:

1. Annual debt service and O & M costs provided by City of Taft.

2. Assumes annual maintenance reserve through year 2002 to fund estimated equipment replacement cost of $200,000 at end of 20-year equipment life. ($200,000 ÷ 9 yrs. = $22,000/yr.)

3. Total annual cost = (column B+C+D).

TABLE 19 AND 20 NOTES:

1. Annual debt service and O & M costs provided by City of Taft.

2. Annual debt service and O & M costs from Appendix C - Table 9.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B - Table 7.

5. Value of effluent from Table 2-18.

APPENDIX D - TABLE 21

ANNUAL CASH FLOW – OPTION 1
SINTON - EXISTING WWTP

(In Thousands of Dollars)

A **Year**	**B** **Annual Debt Service** (Note 1)	**C** **Annual O & M** (Note 1)	**D** **Maintenance Reserve for Future Equipment Replacement** (Note 2)	**E** **Total Annual Cost** (Note 3)
1. 1994-95	$47	$136	-	$183
2. 1995-96	46	136	$60	242
3. 1996-97	43	136	60	239
4. 1997-98	38	136	60	234
5. 1998-99	37	136	60	233
6. 1999-2000	-	136	60	196
7. 2000-01	-	136	-	136
8. 2001-02	-	136	-	136
9. 2002-03	-	136	-	136
10. 2003-04	-	136	-	136
11. 2004-05	-	136	-	136
12. 2005-06	-	136	-	136
13. 20006-07	-	136	-	136
14. 2006-07	-	136	-	136
15. 2008-09	-	136	-	136
16. 2009-10	-	136	-	136
17. 2010-11	-	136	-	136
18. 2011-12	-	136	-	136
19. 1012-13	-	136	-	136
20. 2013-14	-	136	-	136
21. 2014-15	-	136	-	136
22. 2015-16	-	136	-	136
23. 2016-17	-	136	-	136
24. 2017-18	-	136	-	136
25. 2018-19	-	136	-	136
26. 2019-2020	-	136	-	136

APPENDIX D - TABLE 22

ANNUAL CASH FLOW -- OPTION 1
SINTON - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1998
COMBINED WITH TAFT

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	$47	$308	-	-	-	$183	-
2. 1995-96	46	308	-	-	-	242	-
3. 1996-97	43	308	-	-	-	239	-
4. 1997-98	38	308	-	-	-	234	$73
5. 1998-99	37	-	$283	$171	$(-185)	233	73
6. 1999-2000	-	-	283	171	(-245)	196	73
7. 2001-01	-	-	283	171	(-245)	136	73
8. 2001-02	-	-	283	171	(-245)	136	73
9. 2002-03	-	-	283	171	(-245)	136	73
10. 2003-04	-	-	283	171	(-245)	136	73
11. 2004-05	-	-	283	171	(-245)	136	73
12. 2005-06	-	-	283	171	(-245)	136	73
13. 2006-07	-	-	283	171	(-245)	136	73
14. 2007-08	-	-	283	171	(-245)	136	73
15. 2008-09	-	-	283	171	(-245)	136	73
16. 2009-10	-	-	283	171	(-245)	136	73
17. 2010-11	-	-	283	171	(-245)	136	73
18. 2011-12	-	-	283	171	(-245)	136	73
19. 2012-13	-	-	283	171	(-245)	136	73
20. 2013-14	-	-	283	171	(-245)	136	73
21. 2014-15	-	-	283	171	(-245)	136	73
22. 2015-16	-	-	283	171	(-245)	136	73
23. 2016-17	-	-	283	171	(-245)	136	73
24. 2017-18	-	-	-	171	38	136	73
25. 2018-19	-	-	-	171	38	136	73
26. 2019-2020	-	-	-	171	38	136	73

APPENDIX D

SINTON
ANNUAL CASH FLOW TABLES

TABLE 21 NOTES:

1. Annual debt service and O & M costs provided by City of Sinton.

2. Assumes annual maintenance reserve through year 1999 to fund estimated equipment repair/replacement cost of $300,000. ($300,000 ÷ 5 yrs. = $60,000/yr.)

3. Total annual cost = (columns B+C+D).

TABLE 22 NOTES:

1. Annual debt service and O & M costs provided by City of Sinton.

2. Annual debt service and O & M costs from Appendix C - Table 10.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B - Table 9.

5. Value of effluent from Table 2-18.

APPENDIX D - TABLE 23

ANNUAL CASH FLOW – OPTION 1
ODEM - EXISTING WWTP

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D Maintenance Reserve for Future Equipment Replacement (Note 2)	E Total Annual Cost (Note 3)
1. 1994-95	-	$66	-	$66
2. 1995-96	-	66	$20	86
3. 1996-97	-	66	20	86
4. 1997-98	-	66	20	86
5. 1998-99	-	66	20	86
6. 1999-2000	-	66	20	86
7. 2000-01	-	66	-	66
8. 2001-02	-	66	-	66
9. 2002-03	-	66	-	66
10. 2003-04	-	66	-	66
11. 2004-05	-	66	-	66
12. 2005-06	-	66	-	66
13. 20006-07	-	66	-	66
14. 2006-07	-	66	-	66
15. 2008-09	-	66	-	66
16. 2009-10	-	66	-	66
17. 2010-11	-	66	-	66
18. 2011-12	-	66	-	66
19. 1012-13	-	66	-	66
20. 2013-14	-	66	-	66
21. 2014-15	-	66	-	66
22. 2015-16	-	66	-	66
23. 2016-17	-	66	-	66
24. 2017-18	-	66	-	66
25. 2018-19	-	66	-	66
26. 2019-2020	-	66	-	66

APPENDIX D - TABLE 24

ANNUAL CASH FLOW -- OPTION 1
ODEM - CONNECT TO REGIONAL WWTP SYSTEM IN YEAR 1998
COMBINED WITH SINTON AND TAFT

(In Thousands of Dollars)

A Year	B Annual Debt Service (Note 1)	C Annual O & M (Note 1)	D New Pump Station & Force Main Debt Service (Note 2)	E New Pump Station & Force Main O & M (Note 2)	F Regional WWTP Debt Service & O & M (Note 3)	G Total Annual Cost (Note 4)	H Value of Effluent (Note 5)
1. 1994-95	-	$66	-	-	-	$66	-
2. 1995-96	-	66	-	-	-	86	-
3. 1996-97	-	66	-	-	-	86	-
4. 1997-98	-	66	-	-	-	86	-
5. 1998-99	-	-	$209	$118	$(-223)	86	$18
6. 1999-2000	-	-	209	118	(-223)	86	18
7. 2001-01	-	-	209	118	(-243)	66	18
8. 2001-02	-	-	209	118	(-243)	66	18
9. 2002-03	-	-	209	118	(-243)	66	18
10. 2003-04	-	-	209	118	(-243)	66	18
11. 2004-05	-	-	209	118	(-243)	66	18
12. 2005-06	-	-	209	118	(-243)	66	18
13. 2006-07	-	-	209	118	(-243)	66	18
14. 2007-08	-	-	209	118	(-243)	66	18
15. 2008-09	-	-	209	118	(-243)	66	18
16. 2009-10	-	-	209	118	(-243)	66	18
17. 2010-11	-	-	209	118	(-243)	66	18
18. 2011-12	-	-	209	118	(-243)	66	18
19. 2012-13	-	-	209	118	(-243)	66	18
20. 2013-14	-	-	209	118	(-243)	66	18
21. 2014-15	-	-	209	118	(-243)	66	18
22. 2015-16	-	-	209	118	(-243)	66	18
23. 2016-17	-	-	209	118	(-243)	66	18
24. 2017-18	-	-	209	118	(-243)	66	18
25. 2018-19	-	-	-	118	(-34)	66	18
26. 2019-2020	-	-	-	118	(-34)	66	18

APPENDIX D

ODEM
ANNUAL CASH FLOW TABLES

TABLE 23 NOTES:

1. Annual debt service and O & M costs provided by City of Odem.

2. Assumes annual maintenance reserve through year 1999 to fund estimated equipment replacement cost of $100,000.

3. Total annual cost = (column B+C+D).

TABLE 24 NOTES:

1. Annual debt service and O & M costs provided by City of Odem.

2. Annual debt service and O & M cost from Appendix C - Table 11.

3. Amount available for Regional WWTP debt service and O & M costs = (columns G+H) - (columns B+C+D+E).

4. Total annual cost from Appendix B - Table 10.

5. Value of effluent from Table 2-18.