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Environmental Management Program Strategy for Bang Saphan Steel Based Industrial Development

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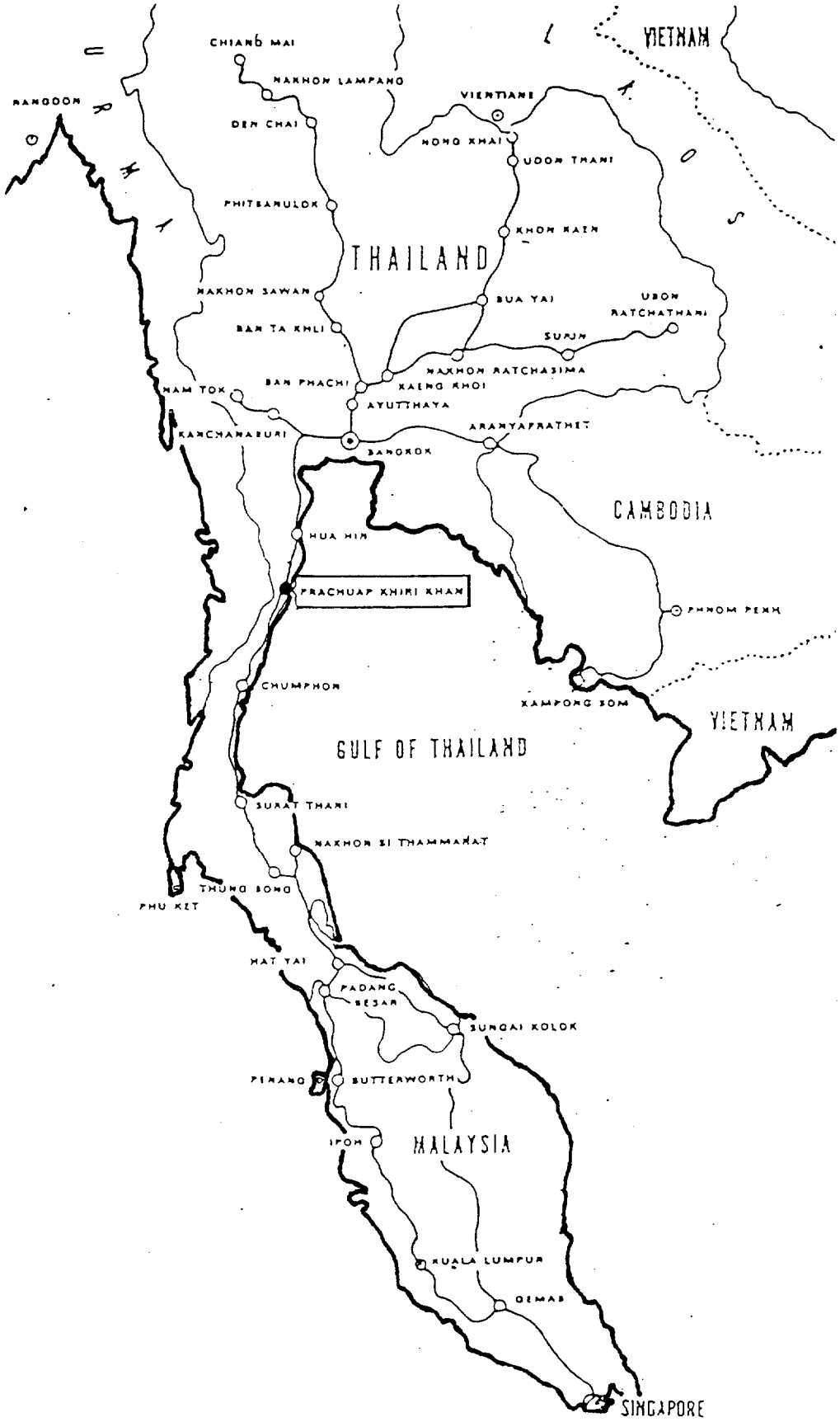


Figure 1
Project Location
Environmental Management Program Strategy

I. Introduction

Sahaviriya Steel Industries Public Company, Ltd., a division of the Sahaviriya Group, has completed the first development phase of a steel industrial complex on Thailand's western seaboard. The site is a 1,750 rai (280 hectare) industrial complex located near Bang Saphan in Prachuab Kirikhan Province (Figure 1).

This strategy paper addresses environmental program management issues related to phases I and II of Sahaviriya Steel industrial complex. Phase I development includes three existing projects: 1) a hot strip mill plant, 2) a steel coating plant, and 3) the Prachaub deep water port. These three projects were constructed within the past two years and are currently in operation. Each project has been the subject of a separate Environmental Impact Assessment (EIA) prepared by in-country technical experts.

Four proposed projects are included in the phase II development: 1) a cold strip mill, 2) a bar mill, 3) an electric arc furnace, and 4) an oil/coal power plant. As required by Thailand's Enhancement and Conservation Environmental Quality Act, separate EIAs will be prepared for each project. Completion of Phase II is anticipated by the year 2000.

This paper has been commissioned by the Office of Energy, Environment, and Technology, Center for Environment, Bureau for Global Programs, Field Support, and Research, U.S. Agency for International Development (USAID) and is intended to provide an initial evaluation of environmental management issues associated with the Sahaviriya's two industrial development phases. Its purpose is to develop an overall strategy for addressing environmental considerations related to this development. This paper includes a discussion of four basic environmental management program elements with identified objectives and general implementation strategies.

Information contained in this strategy paper is based on review of existing technical studies and initial consultation with public agency representatives (listed under References, Section VI), discussions with Sahaviriya staff, and a one-day site visit to the industrial complex.

II. Background

In recent years, steel consumption in Thailand has drastically exceeded the domestically-produced steel supply. Other factors including a continuing trade deficit, a regional imbalance of income level, and an over-concentration of industry and population in the Bangkok area also represent national level policy concerns. In response to these problems, government-sponsored studies have recommended that new steel production facilities be constructed in outlying, less developed regions of Thailand.

Beginning in 1978, technical studies that address both iron and steel industrial development and industrial location in Thailand have recommended Bang Saphan as a potential integrated steel complex site. A major advantage of the Bang Saphan location is the availability of a deep water port site.

A. Industrial Estate Authority of Thailand

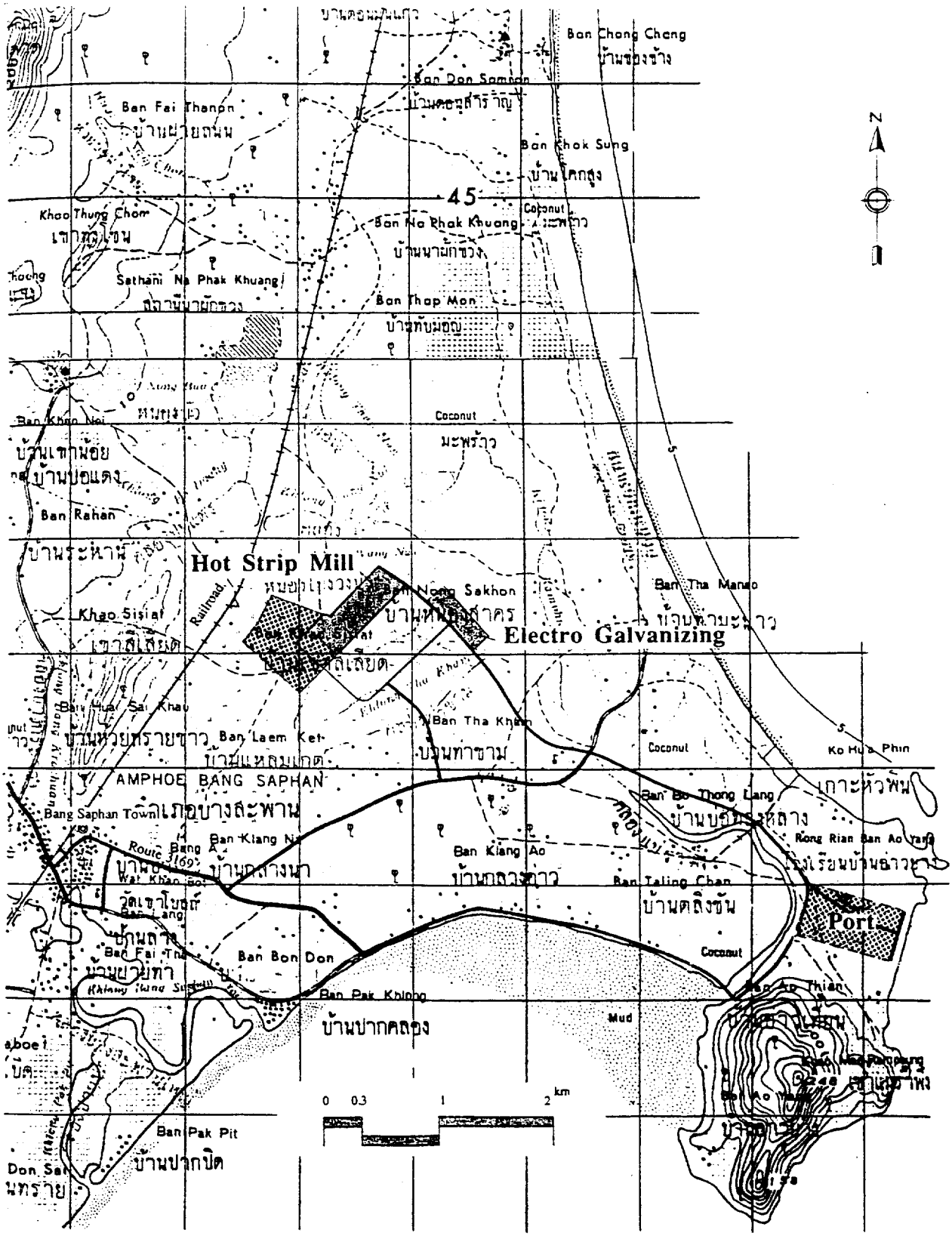
In March 1994 the United Nations Industrial Development Organization (UNIDO) published a conceptual study commissioned by the Industrial Estate Authority of Thailand (IEAT). The study, entitled "Steel Based Industrial Estate in Western Seaboard of Thailand", includes general planning, engineering, economic, and environmental analysis and recommendations for an iron and steel industrial complex in the Bang Saphan area. Sahaviriya's existing steel industry and port development are noted as principal elements of the development plan (Figure 2).

As summarized below, the UNIDO land use plan outlines the development of approximately 20,000 rai (3,200 hectares) by the year 2010. The report proposes two phases for steel industry-related development build out; the first phase includes approximately 4,870 rai or 25% of the total planned development area and its completion is projected for the year 2000. Sahaviriya's two development phases represent approximately 25% of UNIDO's first phase project. The second phase, an additional 15,000 rai, will be built out by the year 2010. Sahaviriya's phase I and II projects represent about 9% of the total development area described in Table 1 and shown on Figure 3.

The UNIDO report contains considerable planning and environmental background information that could prove quite useful to further development planning efforts in the Bang Saphan region. For example, the report identifies environmental issues such as industrial development compatibility with mangrove habitat (discussed in Section B), local fishing communities, and recreation areas (Figure 4).

It should be noted that while the emphasis of the UNIDO's plan is on steel industry-related development, almost 50% of the planned area is designated for new town development and natural resource areas (reserves, rivers, etc.). UNIDO suggests a joint public/private approach to new town (housing) construction.

Primary elements of the UNIDO report's land use development recommendations are outlined on Table 1.



Source: UNIDO, 1994

Figure 2
Sahaviriya's Existing Development
Environmental Management Program Strategy

Table 1. UNIDO Land Use Plan for Bang Saphan Iron & Steel Industrial Complex*

Land Use Type	Size (rai)	(ha)	% of Area
• Port	1,000	160	5.0
• Iron & Steel Industry	2,750	440	13.8
• Coal Fired Power Plant	1,750	280	8.8
• General Industrial Estate	2,440	390	12.2
• Export Processing Zone	1,120	180	5.6
• New Town & Business Park	3,940	630	19.6
• Roads & Utilities	1,500	240	7.5
• Other (natural reserve, river, etc.)	5,500	880	27.5
Total	20,000	3,200	100.0

* UNIDO (1994)

B. Coastal Conservation Plan

A coastal conservation planning study is currently being prepared by natural resource experts at a Bangkok university. Scheduled for completion in December 1994, the plan will include natural resource inventories of the entire industrial complex planning area and will include about 100 kilometers of western seaboard coastline. Figure 5 shows the Coastal Conservation Planning area.

The plan is expected to designate specific development zones for land located between Route 4 and the shoreline, the area in which Sahaviriya's project sites lie. Conditions for development will be stipulated for the three following zones: 1) Conservation, 2) Preservation, and 3) Development.

Previous environmental studies of the industrial complex area have characterized portions of the area as environmentally sensitive coastal marsh land with valuable mangrove swamp habitat. It is likely that the coastal conservation plan will recommend some protection measures for this habitat.

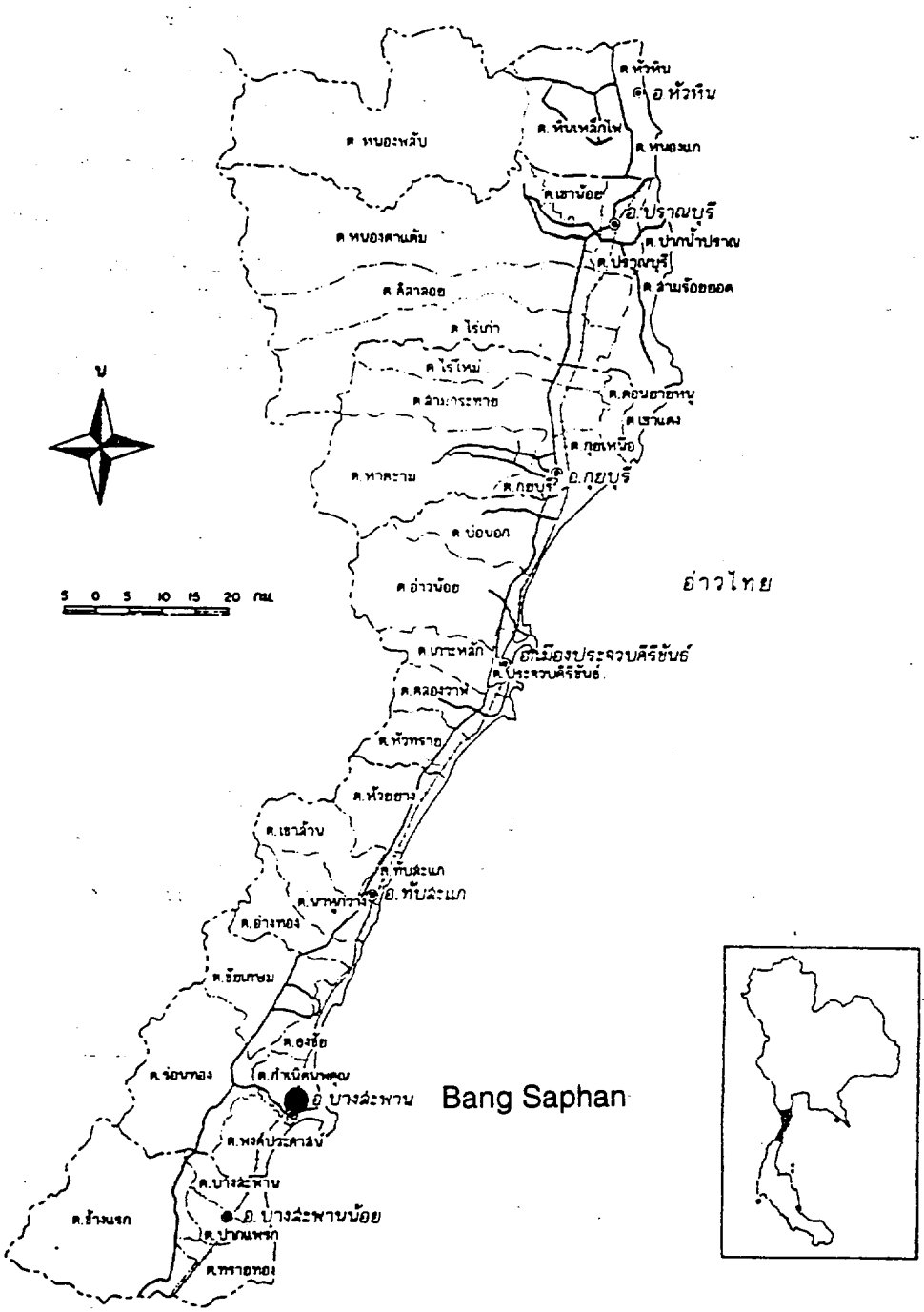


Figure 5
Coastal Management Planning Area
Environmental Management Program Strategy

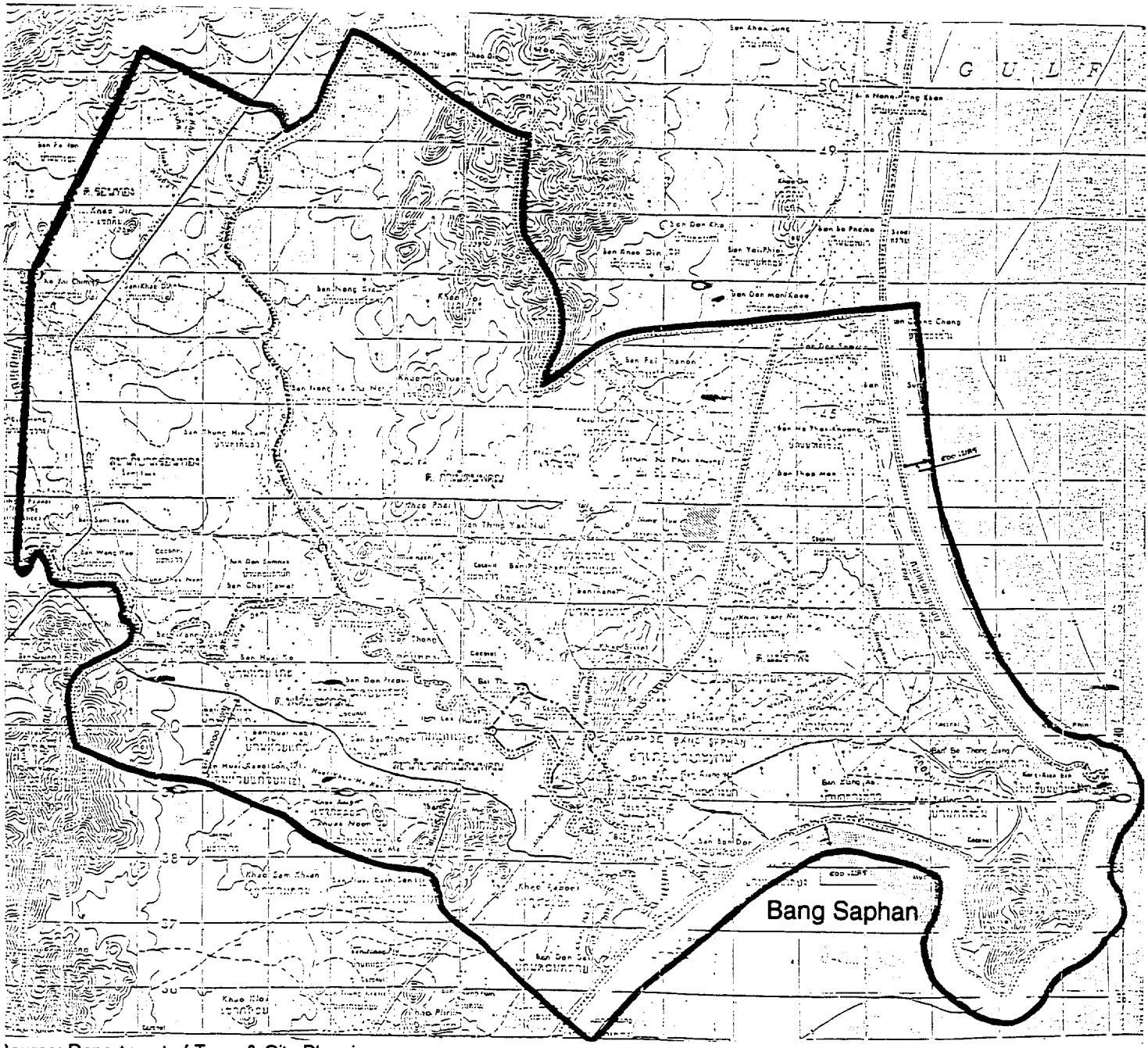
C. Government Planning Policy

In Thailand, the Ministry of Interior and the Ministry of Science, Technology and Environment are responsible for developing physical and social planning policy. These governmental planning agencies have gathered data regarding existing social and physical conditions and will, in the future, prepare plans and policies for a 170 square kilometer planning area that encompasses the Sahaviriya phase I and II project sites. Figure 6 shows this planning area boundary.

Initial background consultation was conducted with several planning agency representatives as part of this study. Consultation meetings were held in various government planning offices in Bangkok. Discussions with planning agency representatives resulted in identifying a range of community/regional scale planning issues that will need to be addressed in an overall regional planning study for the area that includes Sahaviriya's project sites. Additionally, it was suggested that consultation with local area representatives such as the provincial governor and sanitiary districts be incorporated into the planning process.

Key planning issues that were identified by government planning agencies are listed below.

- Water demand/supply constraints
- Water and air pollution
- Infrastructure requirements
- Housing requirements
- Community amenities such as greenbelts/buffers, schools and parks
- Protection of mangrove habitat
- Population growth/migration and labor force requirements
- Social/cultural effects on existing local population



Source: Department of Town & City Planning,
Ministry of Interior

Figure 6
Ministry of Interior Regional Planning Area
Environmental Management Program Strategy

III. Environmental Mitigation and Monitoring Program- Sahaviriya's Phase I Project

Sahaviriya's phase I project- the hot strip mill, the steel coating plant, and deep water port- are all currently operational and subject to specific mitigation and monitoring requirements per the governmental approved Environmental Impact Assessment documents. This section contains a brief summary of those environmental requirements. Photographs of phase I facilities are shown in Figures 7, 8, and 9.

A. Pollution Control Measures

The measures described herein are those presented in the EIAs and were designed to control emissions/effluents to the environment. Measures to protect in-plant, or occupational health and safety were not included as part of this paper.

1. Hot Strip Mill

• Air Emissions: Air emissions are primarily from the burning of heavy oil in the reheating furnace. Because the heavy oil contains less than 1.25% sulfur, the emissions from the 80 m stack of sulfur dioxide (SO_2), nitrogen oxide (NO_x), suspended particulate matter (SPM), and photochemical oxidant (O_3) was calculated to be within the industrial emission standards developed by the Industrial Environment Division of the Ministry of Industry. Thus, there are no emission control equipment currently installed in the hot strip mill.

• Process Wastewater and Cooling Water: Water used in the milling process is collected and piped to the scaling pit where solid materials, particularly iron (Fe) is settled out of the wastestream. The wastewater is then pumped to the oil/water separator to remove the majority of the lubricating oils. From the separator the wastewater is piped to six sand filters for the final treatment process. Make-up water from the raw water treatment plant is added to the treated wastewater and recycled back to the process and cooling water streams. Thus, no process wastewater is currently discharged from the mill: all process and cooling water is recycled.

• Solid Waste: Solid wastes in the form of sludge is currently generated from process wastewater treatment systems, 2) the raw water treatment system, and 3) from the domestic wastewater treatment system. Scrap metal wastes is temporarily stored on-site. Sludges from the process wastewater treatment systems and from the raw water treatment system are sent to drying beds for separation. The dry material is stored on-site, then collection by a private company and disposed off-site. Fluids from the process are sent to the leech field in the northwest corner of the industrial complex.

Iron from the scale pit is periodically collected and sold to a private company for off-site reprocessing.

Figure 8
Photographs - Steel Coating Plant
Environmental Management Program Strategy

Figure 9
Photographs - Deep Water Port
Environmental Management Program Strategy

Scrap metal from the crop shearing step, and rejected slabs and/or cold coils are stored on site and then are shipped off site to a smelting plant either in Sarmutprakarne, or Rayong.

• Surface Runoff: Surface water runoff from the sloped slab storage yard, and the scrap metal storage area is directed to drainage ditches around each area. These ditches are currently closed although there are plans to connect the ditches to the dredged drainage canal which runs through the center of the complex. Surface runoff from other plant areas is not collected, but is directed to the dredge drainage canal.

2. Electrogalvanizing (Coating) Plant

This plant was not in operation at the time of the site visit: the following information is based on interviews conducted with plant management personnel.

• Air Emissions: As the coating process does not emit to the environment suspended particulate matter (SPM), SO_2, NO_x, or O_3, at or near the levels of the industrial emission standards, no control measures have been installed within the facility. Internal emissions of H_2SO_4 in the pre-treatment and plating processes are controlled by Lamellar mist separators. Post-treatment processes produce hazardous CO_3. This oxide also passes through a mist separator, thereby eliminating emissions to the environment. Kerosene burned in the drying oven contains less than 2.5% sulfur. The use of automatic fuel injectors and low sulfur content eliminates the emission of SO_2 and NO_x to below significant levels.

• Process Wastewater: The three major sources of process wastewater originating form the coating process. The sources are from:

- electrogalvanizing process;
- oil contaminated and blown downwater; and
- domestic wastewater systems

The wastewater from the electrogalvanizing process contains toxic substances as Fe, Zn, and Cr. Three separate waste streams (Cr-Zn, Fe-Zn, and Alkali-acid line) are treated through the chemical precipitation process. Specifically, the heavy metal stream is passed through pH adjustment tank, reduction tank, precipitation tank, clarifier and finally through a filter press to produce a dry cake. The steam is then recycled back to the production process.

Oil contaminated and blown down water resulting from contact with the various processing equipment and from the maintenance shop(s) pass through an oil/water separator. The oil from the surface of the separator is collected in a skimmer oil pit and then is pumped into a storage tank for off-site disposal.

Domestic sewage is treated by two different systems. The first, from toilets is treated by a package seepage system unit. The second, from the canteen and offices is treated by the activated sludge and sludge drying bed method.

Treated effluent from the steel coating process, and the oil contaminated and blown downstream is discharged to a hold pond (unlined). After a minimum of one day, the effluent is discharged to the complex's drainage canal. The small amount of treated effluent from both domestic wastewater treatment systems is sprayed on the surrounding landscape.

The electrogalvanizing process does not use cooling water. The finished coated sheet steel is air cooled, thus eliminating the need to use and/or treat other waste stream.

• Solid Waste: There are two types of solid wastes generated from the coating facility. The first is the domestic waste comprised of office, and kitchen wastes. These wastes are separated and temporarily stored on-site. The material is collected and disposed of off-site by a private contractor. The second type is the hazardous sludge cakes produced as the final step in the electrogalvanite wastewater treatment process. These "dry" cakes are temporarily stored in drums on site, and periodically shipped off-site for hazardous waste treatment, and disposal.

3. Deepwater Port

• Air Emissions: As currently operated there are no point source emissions from the port facility.

• Wastewater: Wastewater from sink and toilet facilities are disposed of via a septic tank and package units of anaerobic filter(s).

• Solid Waste: Solid waste from port facilities is currently collected in a open storage container with the contents burned at a nearby suitable site. Shipboard wastes are disposed of prior to docking at the port.

B. Environmental Monitoring Programs

This section presents an overview of the environmental monitoring programs stipulated in the EIA documents for the phase I facilities. Specifically, these facilities are to the hot strip mill, the steel coating plant, and the deep water port. A detailed description of each monitoring program is contained in the respective EIAs which are referenced at the end of this paper.

A. Hot Strip Mill

Parameters	No of Locations	Frequency
Ambient Air Quality:		
Dust (particulate) SO_2, NO_2, wind velocity and direction	3	Twice a year for 7 consecutive days
Emission Sources:		
Dust (particulate) SO_2, CO	1	Twice a year, for 7 consecutive days

In addition, document the sulfur content of fuel oil supplied to the plant in a report sent to the Office of Environmental Policy and Planning.

Treated Wastewater:		
pH, DS, TDS, SS, oil and grease, BOD, COD, Cl, Sulfide, Cyanide, Zn, As, Cu, Cd, Fe, Pb Hg, Mn, and Si	1 (wastewater pond)	Twice a year
Surface Water:		
pH, SS, TDS, acidity, alkalinity, COD, oil and grease, total coliform, Si, Fe, and Mn	3	Twice a year (6 months/yr)
Groundwater:		
pH, SS, BOD, oil and grease, Mn, Si and Fe	6 observation wells	Twice a year (6 months/yr)
Noise (outside of plant):	7	3 times a year (4 months/time)

B. Steel Coating Plant

Parameters	No. of Locations	Frequency
Ambient Air Quality:		
TSD (SPM), SO_2, and NO_2	2	Twice a year, 3 consecutive days each time
Emission Sources:		
TSP and SO_2	Stacks	Once a Year
Treated Wastewater:		
flow rate, pH, SS, TDS BOD, oil and grease, Cr, Zn, Fe, and Al	2 (one before CTP, and at end of pipe to Klong Mae Ramphung)	Monthly
Surface Water:		
Flow rate, pH, SS, TDS, COD, oil and grease, Cr, Zn, Fe, Al, NO_3^{-3}-P, PO_4^{-3}-P, total coliform, and acidity/ alkalinity	1 (Klong Mae Ramphung)	Every month BOD, dry season; every 3 months in rainy season

C. Deep Water Port:

Parameters	No. of Locations	Frequency
Seawater Quality SS, turbidity transparency, pH, oil and grease, DO, and fecal coliform	7	Quarterly
Benthic Fauna:	2	Once a year
Sedimentation Rate:	6	Twice a year
Strand Oil:	Every 200 m along the distance of 5 km north and south of breakwater	Twice a year
Oil/water Separator:	At oil/water separator discharge point	Every two months
Effluent from anaerobic filter: BOD/COD, SS, pH, and coliform bacteria	Every anaerobic system discharge point	Every two months

Legend

pH = acid
DS = dissolved solids
TDS = total dissolved solids
SS = suspended solids
BOD = biological oxygen demand
COD = chemical oxygen demand
Cl = cloride
Zn = zinc
Cu = copper
Cd = cadmium
Fe = iron
Pb = lead
Hg = mercury
Mn = manganese
Si = silicon
As = arsenic

IV. Anticipated Emission and Effluent Releases- Sahaviriya's Phase II Project

The pollution control and/or mitigation measures for the cold strip mill, steel bar mill, power plant, and the electric arc furnace have not been identified at this time. As separate EIAs are prepared for each project, mitigation measures and environment monitoring programs may be stipulated. References reviewed in the preparation of this section include the UNIDO report (Volumes 1 and 2, November, 1993 for the cold strip mill), the preliminary feasibility study for the steel bar mill, the interim feasibility report for the Sahaviriya Steel Industries, September 1994, and the World Bank general description documents on iron and steel manufacturing (electric arc furnace). In addition, discussions were held with Sahaviriya Steel Industry personnel regarding expected design and implementation of all the two phase facilities.

A. Potential Emission/Effluent Releases

The emissions described herein are those that may be released to the environment; in-plant emissions is not addressed in this paper.

1. Cold Strip Mill

• Air Emissions: Emissions from this facility will primarily be from the continuous pickling line and tandem cold mill units, as well as from the batch annealing furnace. The particular pollutants from these sources are not know at this time, however, the use of low sulfur fuel oil (less than 1.25%) should reduce the need of pollution control equipment in the furnace stack. The acid(s) used in the pickling process may be recovered in a recovery system, and recycled thus potentially eliminating emissions to the environment.

• Process Wastewater and Cooling Water: Water requirements for the facility will be broken into two systems; one is the filtered water used in the milling process, the second is circulated water used for cooling. The filtered water will be treated and then discharged indirectly to the complex's central drainage canal. This water may be first discharged to a retention pond on site, then discharged to the canal.

Cooling water will probably be recirculated with make-up water coming from the complex's raw water supply system.

Solid Waste: Consumable wastes includes wrapper paper, protective pads, steel ring and hoop bundling. These and other miscellaneous wastes will (may) be collected and disposed of off-site as currently done for the phase I facilities. Domestic waste from this facility as well as from the other phase II facilities will be treated in a central sewage treatment plant to be built. Solid wastes from this facility may be disposed of off-site.

Surface Runoff: Off-site fill material will be brought into the proposed mill site. Upon completion of final compaction and contouring, a drainage ditch will surround the complete facility. The runoff (rainwater and washwater) will be collected in the ditch, and then collected in a pit(s) for temporary settling. The water in the pit will be discharged to the central drainage canal which connects to the Klong Mae Ramphung.

2. Steel Bar Mill

• Air Emissions: The source of emissions from this facility will primarily be from the reheating furnace, used to prepare the steel billets for the rolling machine. As with the other projects, low sulfur fuel (less than 1.25%) will be used in the furnace. Thus, the use of emission control equipment for the removal of SO_2, SPM, NO_X, or O_3 is not anticipated at this time.

Process Wastewater and Cooling Water: The type of mill to be installed was not known at the time of the preparation of this paper. However, a general description of the process wastewater treatment and cooling water recycling is provided. A detailed description of the mill and wastewater treatment systems will be contained in the forthcoming EIA.

In general, there will be three main process wastewater streams. The pickling/coating process will be a mild/weak acid/lime solution which will be recycled with no discharge to the environment. The process streams used in shaping and cutting the bar will contain metal fines which will settle out in the scaling pit(s) and disposed of off-site. The process wastewater will probably pass through a series of filters, and recycled through the mill with make-up water supplied from the raw-water treatment plant. Finally, cooling water will be circulated through the various mill stands and cutting shears. The cooling water will first pass through a settling tank, then through an oil/water separator and then through one or more filter(s). As with other process water, the cooling water stream will be recycled through the mill with addition of raw make-up water added to the stream as needed. As currently planned, there should be no discharge of treated wastewater from the bar mill.

Domestic wastewater from the facility will be treated and discharged from the central sewage treatment plant.

Solid Waste: As in the cold strip mill, the major source of solid waste will be consumable materials as wrapper paper, protection pads, ring and/or bundle wire. These and other miscellaneous solid wastes will be collected and disposed of off-site. Scrap metal will be stored on-site and sold on a periodic basis.

Surface Runoff: As with all the other projects, fill material will be brought into the proposed site of the steel bar mill. Upon completion of final compaction and contouring, a drainage ditch will surround the facility. Surface runoff will be collected in a ditch, pass to a pit(s) for temporary settling, and then discharged to the central drainage canal.

3. Power Plant

• Air Emissions: As currently planned, the power plant will be constructed in three phases. The first phase (1997) includes the installation of a simple cycle combustion turbine (CT), the second phase will include the addition of a combined cycle combustion turbine, and around the year 2000, an integrated coal gasification combined cycle system will be added. Thus, the emissions from the power plant will change over a three year period starting in 1997. It is anticipated that low sulfur fuel (less than 1.25%) will be used in the simple and combined cycle CTs. The use of this fuel should significantly reduce the typical power plant emissions for SO_2. If this fuel is used, then no emission control equipment is expected to be installed. If and when an integrated coal gasification cycle system is installed, the emissions from the plant will change. However, what if any control equipment that will be needed will be identified in the pending Environmental Impact Assessment (EIA). Another potential source of air emissions may be particulate matter from the coal pile(s) to be located adjacent to the plant.

The specific potential air emissions and required mitigation measures for the plant will have to await the selection of fuel, and the approval of the final EIA.

Process Wastewater: As the specifics of the power plant have not been developed, the type of process wastewater treatment is not known. However, it is expected that several treatment systems will be installed to handle boiler blown down, demineralizer backwash and resin regenerator wastewater, residual transport wastewater, runoff from coal piles, and the site, as well as from domestic wastewater. Oil treatment system(s) may also be needed to treat various oil soils, and oily runoff from around the fuel oil storage tanks. The pending EIA will address these wastewater systems and appropriate treatment system will be installed at the plant.

The power plant will use once through cooling water when the plant installs the gasification combined cycle system. Depending on results of the cooling water studies, entrainment and impingement of aquatic organisms as well as potential fishery impacts resulting from the location of the outfall and the elevation of ambient water temperatures will have to be assessed. Reducing these potential impacts will be addressed in the forthcoming EIA.

Solid Wastes: Solid wastes generated by the power plant will primarily be coke from the gasification process and domestic (sewage and office) waste. Nothing is known at this time about the quantity and quality of each type of waste. This information will probably be included in the final feasibility report currently under preparation.

4. Electric Arc Furnace

Air Emissions: Emissions from this project to be in operation in 1999, will include primarily dust (particulates) and CO. This assumes a high grade iron ore will be used in the furnace. Control of the particulates may be accomplished with the use of cyclone separators followed by electrostatic precipitator(s), and bag house. A control technology for CO will have to await the results of the feasibility study for this project.

Process Wastewater: Solvents and/or weak acids solutions may be used in cleaning steel or the "raw" scrap iron to be used in the furnace. These solutions should be handled, stored, and disposed of as hazardous substances. Treatment systems and possible recycling equipment may be installed at this facility.

Furnace wall and roof cooling water is anticipated to be treated and recycled, thus eliminating the need to discharge to the central drainage canal.

Solid Wastes: The expected major source of solid wastes is the dust collected from the stack emission control system(s). Frequently this dust has some economic value because of the alloy mixture in the dust. The dust however can contain toxic metals. Analysis of the dust should be done prior to and after start-up of the power plant.

Consumable materials, like the other complex projects will be collected on-site, and disposed of off-site.

Surface Runoff: Surface runoff from the scrap iron/separation yard and scrap product yard should be tested to determine what if any treatment is necessary prior to discharge to the central drainage canal. The runoff may be held in a retention pond to settle out any suspended solids..

B. Environmental Monitoring Programs

As the EIA reports have not been prepared for the four projects to be constructed during Phase II, it is beyond the scope of this paper to identify monitoring programs to be identified and approved by the Ministry of Interior, and the Ministry of Science, Technology and Environment.

V. Environmental Management Program Strategy

Overview

The Sahaviriya phase I and II projects represent an important increment of industrial development for Thailand's western seaboard region. By developing and implementing a strategic environmental management program for Sahaviriya's projects at this time, the beneficial social, economic, and environmental aspects associated with new development can be maximized while potentially adverse effects on the natural and social environment are reduced.

The economic and environmental consequences associated with phase I development have been evaluated and specific mitigation measures designed to reduce adverse environmental effects have already been identified. Similar evaluations of the planned phase II projects are in progress. In addition to implementing specific mitigation measures and monitoring programs identified in the EIA documents, a program of broader measures or actions are suggested herein to ensure long-term environmental conservation goals and maintain Sahaviriya's positive image as an environmentally responsible company.

The strategy for an environmental management program discussed below contains four basic elements. Objectives, implementation strategies, and a general time frame are identified for each program element. The suggested timing for program implementation is based on current available information regarding Sahaviriya's schedule for phase II completion.

A. Support a Comprehensive Regional Planning Process

Objective: To ensure private development coordination with government programs in respect to infrastructure construction, natural resource conservation, and social /physical planning policy. Coordinated regional planning efforts will lead to a more efficient project approval process and potentially more government and outside (international) financial support for infrastructure improvements.

Taken together, Sahaviriya's phase I and II facilities represent about 25% of the total development proposed in UNIDO's first development phase. Sahaviriya development will certainly play an influential role in shaping future growth and environmental conservation in the Bang Saphan region. Sahaviriya's proactive participation and support for a regional planning process would, in the long run, result in strengthening financial support from the government and international funding organizations for infrastructure construction as well as potentially lead to a more expedient project approval process. Given active support, a regional plan should therefore reflect input from and meet the objectives of the area's major steel based industrial developer.

Support for a regional planning effort can be accomplished by at least two alternative means. One approach involves providing sufficient development plans and data to the appropriate governmental planning body, perhaps the Ministry of Interior or the IEAT, for use in preparing population projections, infrastructure requirements, planning/environmental policies, etc. An alternative to this approach would be to participate in the actual planning process by providing technical assistance to government planning agencies. This could involve partially funding a technical planning position or consultant efforts to assist in the preparation of a regional plan, policies, and supporting technical data base.

The first approach would be less costly to Sahaviriya, however would probably require a greater time period for actual plan and policy preparation. The second alternative would involve more direct financial cost but would likely result in a more timely planning process. Other potential sources of financial support for regional planning such as the Ministry of Science, Technology and Environment's Environmental Fund could also be explored.

Regional planning issues to be addressed include population growth/in-migration; water supply; natural resource preservation/protection; buffer/greenbelt requirements; infrastructure requirements; housing requirements, school and park requirements; and labor force/job training requirements. The planning process should also consider input from local government representatives such as the provincial governor and sanitary district officials.

Several steps could be taken within the next three months, regardless of the technical planning approach that Sahaviriya and governmental planning agencies select. These involve:

- Determining the appropriate lead planning agency (IEAT, Ministry of Interior, etc.),
- Determining the appropriate planning area/subarea boundaries, and
- Assessing the status of available data on existing physical/social conditions (population, land use, natural resources, etc.).

Terms of Reference (work program and scope) for developing the plan and actual planning activities should be undertaken as soon as practical.

B. Develop and Implement a Public Information and Community Relations Program

Objective: To communicate accurate factual information about Sahaviriya's existing and proposed operations in order to maintain a positive environmental image and build public acceptance for the Bang Saphan steel-based industrial development.

A variety of programs and techniques can be implemented to achieve public information/community relations goals. Sahaviriya could create an environmental information officer position by hiring a staff member with technical expertise in environmental issues and public communication. (The information officer could be a member of the proposed Environmental Management Group presented in Section D).The environmental information officer's primary responsibility would be to address community questions, concerns, and problems related to construction and operation of Sahaviriya's projects. The environmental information officer would also be available for speaking or distributing informational materials at local community events.

A second aspect of the program involves establishing an outreach program in local schools. Sahaviriya's environmental information officer could schedule presentations at local school sites to discuss issues of interest to students. Topics might include an overview of Sahaviriya's industrial operations, reasons for facility access restrictions, and environmental/public safety procedures. Environmental education trips could be scheduled so that school children from the community could visit Sahaviriya facilities and learn about established environmental protection measures. The school outreach program will enable local/regional students to learn more about Sahaviriya's commitment to industrial development as well as protecting the environment. As a consequence of the outreach program, the children's parents may also become aware of this information. A longer term benefit of the school outreach program will be to encourage understanding and acceptance of Sahaviriya steel industrial development in local community residents at an early age.

The overall time frame for implementing this program element is six to nine months. A job/qualification description for the environmental information officer position could be developed and the position filled within the next two to four months (See Section D). The school outreach program should be established as soon as the environmental information officer is in place, and Sahaviriya personnel are trained in conducting site visits.

C. Develop and Implement an Environmental Enhancement Plan

Objective: To ensure long-term conservation of sensitive natural resources and environmental quality in the vicinity of Sahaviriya facilities and to maintain Sahaviriya's positive public image as an environmentally responsible company.

The purpose of the environmental enhancement plan would be to develop a document that defines environmental quality and public health/safety standards for Sahaviriya's development projects. Elements to be included would be infrastructure, open space, recreation, and drainage, among others. The enhancement plan would incorporate professionally accepted international planning/design standards and criteria; the plan would be prepared in conjunction with planning and implementation of Sahaviriya's phase II and anticipated future development in the Bang Saphan area.

The plan would include identified on and off-site enhancement measures that are coordinated with regional planning goals and policies. It is anticipated that to some extent, responsibility for implementing or maintaining selected enhancement options could become a shared public/private sector responsibility. The plan could include a phased investment/construction approach for implementing enhancement measures. The following are some initial examples of planning/design issues be addressed in Sahaviriya's environmental enhancement plan.

• Facility layout criteria and guidelines that reflect efficient use of the land (and water) in order to minimize development-related environmental impacts. Where feasible and cost-effective, facilities could be centralized or consolidated to further reduce environmental impacts.

• Water discharge and drainage system design criteria for minimum alteration to existing natural drainage and off-shore hydrology patterns.

• Criteria for local community traffic circulation and industrial facility traffic including consideration of a separate roadway network to accommodate trucks/heavy equipment during construction as well as for on-going facility operations. Siting, design, and construction criteria and standards for new project access roads that are sensitive environmental considerations.

• Criteria and standards for buffer zones and development setbacks to preserve natural habitat areas and aesthetic resources and to promote public safety. These could include building/development setbacks from water courses, drainage ways, and shoreline areas and access road/entry point aesthetic treatment (Urban Land Institute, Pratt Institute, or other professionally/internationally accepted industrial development standards would be applied).

• Criteria for enhancing/maintaining public access to existing local beaches and recreation areas . Access routes could be separate from those used by facility construction and operational traffic. Measures for view protection from local recreation areas including potential for landscape screening to reduce visibility of industrial facilities from public recreation areas. Where/if applicable, criteria and standards for new/replacement recreation areas.

The environmental enhancement plan could be prepared by Sahaviriya technical staff or by technical consultants. Professionals with expertise in environmental/ urban planning and site planning/design should contribute to and review the plan. The plan could incorporate data from and build upon previous studies such as the coastal management plan and UNIDO report. A scope and work plan for preparing the Sahaviriya's Environmental Enhancement Plan should be developed within the next six months.

D. Develop an Environmental Management Division within Sahaviriya Group

Objective: To create in-house environmental expertise and capability for managing environmental/regional planning, mitigation requirements, and environmental monitoring programs

A variety of activities that are now dispersed within Sahaviriya Steel Industries (SSI) and government agencies can be facilitated by establishing an environmental management group within SSI. The group's primary function would be to assist planners, engineers, and site managers in managing environmental matters associated with facility planning, design, construction, and operation. A secondary group function would be to maintain current knowledge on environmental regulations and compliance issues so as to provide expert advise to SSI management on environmental issues.

During the phase II planning process, this group could participate in the final site selection for facilities, provide design criteria (pollution control), and identify order of magnitude cost associated with project mitigation requirements. During EIA preparation, the environmental group could supply information about expected emissions and effluent discharges, and provide consultation to government agencies on prudent and feasible mitigation measures and appropriate environmental monitoring programs. Organizationally, the environmental information officer assigned to the industrial complex could be part of the environmental group, reporting to the environmental group manager.

Technical staff within the environmental group could be responsible for long-term environmental monitoring during the construction and operation of phase I and II facilities. The staff could function as a central clearing house and /or also prepare the required monitoring reports to be submitted to regulatory agencies. Finally, members of the group could conduct environmental training programs for construction and operational personnel.

Initially, the environmental management group would work out of SSI's Bangkok office and would consist of a small core staff of three to four people including the environmental information officer. Longer term (after six months), the group could be located at the Bang Saphan complex and could be expanded to include a water quality laboratory and personnel. The initial group could be comprised of one or more environmental scientist(s), environmental engineer(s), and a biological specialist.

The environmental management group should be established at Bang Saphan within the next six to nine months. The group's staff and technical capabilities can be increased as the Bang Saphan development complex expands. Within one to two years the environmental management group could assume broader responsibilities for other Sahaviriya companies' environmental compliance activities. Eventually, and with proper planning and staffing, the proposed environmental management group could become a profit center within the Sahaviriya Group and/or a small subsidiary environmental consulting firm.

VI. References

The following documents were reviewed as background for preparing the Sahaviriya environmental management strategy paper.

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Initial consultation with government planning agencies was conducted as background for preparing this paper. Included were discussions with the following people.

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