4.11.1 POWER OVER TECHNOLOGY

In addition to the power *of* technology, Wartofsky (1992) discusses power *over* technology in his work on the democratization of technology. Power over technology is the power that technology makes available; this is typically power for either elites within a technology's institution, or consultants and experts outside its institution (see figure 4-11).

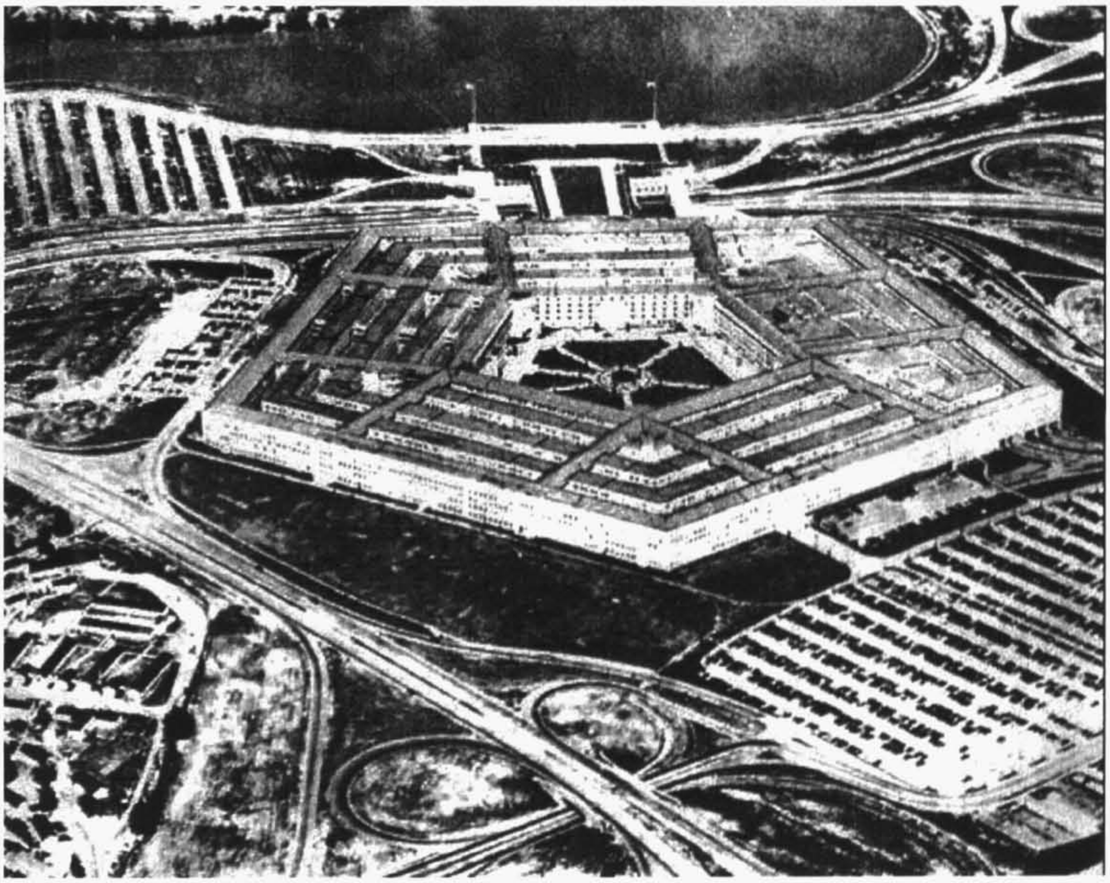


Figure 4-11: Power over Technology and the Concentration of Power
(Source: "Pentagons of Power" in Mumford, 1964, p.187)

The GORO Association is a technology that provides such power to its executive leaders for making decisions about the association. Private companies recognized this power and intentionally convinced the executive leaders to use it in an inappropriate way. Unfortunately, the executive leaders agreed to use their power for their own benefit.

4.11.2 INSTRUMENTALISM AND THE IMPACT OF TECHNOLOGY

According to the concept of technological imperatives proposed by Winner (1977), the invasion of forest areas and the degradation of rivers result from the construction of maintenance roads. In the conventional understanding of instrumentalism, a technology is used as a means to achieve an end. This case study demonstrates that not only the technology itself but also its impact can be means to achieving an end, but it may be a different end. Accordingly, the impacts resulting from technological imperatives were utilized by the Governor of Yogyakarta as one of his main reasons for proposing the national park plan; however, with this proposal three other opportunities – the status symbol, income from tourism, and access to reforestation funding – could be realized.

4.11.3 OPPORTUNITIES ARISING FROM ALIEN VALUES

Once the plan for the national park was revealed, a mining company – a new actor – came on the scene as a sponsor for the scheduled launch ceremony. Its appearance increased the local villagers' doubts about whom the national park was for. As incidents of corruption in the National Park Management Body were well known, the newly established national park was expected to become a source of bribes for officials of the National Park Management Body.

The national park opens up a potential business opportunity for a number of mining companies, and makes bribes possible for officials in the National Park Management Body. This situation has occurred because of the powers of technology derived from the new challenges and feasibilities noted by Jonas (1979) and from the generated alien values of the park noted by Marcuse (1964).

4.11.4 IMPERATIVES OF SOLUTIONS

As suggested by Winner (1977), a consideration of the imperatives of technology provides helpful insights. An agricultural loan program requires several types of input and support systems, such as lands for cultivation, markets for product sales, and fertilizers and pesticides for crop growing.

These requirements are not under the full control of the government. As a result, stakeholders who own these assets will also want to obtain benefits from the loan program. Unfortunately, their pursuit of benefits could potentially harm the success of the loan program.

4.11.5 BACKGROUND PHENOMENA OF STAKEHOLDERS

Another interesting point is that, compared with the expenditure by the government and the risks taken on by locals in a loan program, private sand-mining companies will probably enjoy their sand-mining activities without confrontations with the local sand miners, who can be expected to turn their attentions to the loan and the new agricultural activities associated with it. In other words, the private companies are the real free-riders of such a loan program. Thus, a critical question is evident: who is the government actually assisting under such loan program?

This situation shares a sense of balanced issues similar to that demonstrated in the concept of background relations proposed by Ihde (1990). His understanding is that once a background object, such as a refrigerator or an electrical network, stops working, it will cause severe damage or impacts:

> *"The involvement implications of contemporary, high-technology society are very complex and often so interlocked as to fall into major disruption when background technology fails. In 1985 Long Island was swept by Hurricane Gloria with massive destruction of power lines. Most areas went without electricity for at least a week, and in some cases, two. Lighting has to be replaced by older technologies (lanterns, candles, kerosene lamps), supplies for which became short immediately ... Similarly, with the failure of refrigeration, eating habits have to change temporarily. The example could be expanded quite indefinitely ... Background technologies, no less than focal ones, transform the gestalts of human experience and, precisely because they are absent presences, may exert more subtle indirect effects upon the way a world is experienced. [Ihde, 1990, pp. 111-112]"*

This means that what is in the background when a technology is applied is very important. While not identical, a similar phenomenon in terms of balanced issues occurs in a chain of solutions. The private companies are background factors. No attention will be paid to them, although they will be reaping some benefits. A lesson to be learnt is that the concept of background relations proposed by Ihde (1990) can be helpful in stakeholder analysis for identifying background stakeholders, if any, who may be losing or gaining benefits during the development of a solution chain.

4.12 ONE IMPLICATION OF OPPORTUNITIES

During the development of a solution chain, there are successive solutions and new impacts. As described in the previous section, these solutions and impacts are actually opportunities for certain actors. To increase their opportunities, these actors may also attempt to either influence the preferred solution or enlarge the impact. This section provides a speculative discussion about strategies that some actors in this case might or could have used to increase their opportunities.

The GORO Association was the solution that the local sand miners employed to resolve their disadvantaged position. The private companies might have obtained greater benefits if they had not totally destroyed the GORO Association, but instead sought to control the principle-agent problems to some degree. With the GORO Association under the control of the private companies, pervasive illegal sand quarrying in the area could have been pursued without much difficulty.

The national park was devised as a solution for environmental impacts. The mining company who sponsored the launch ceremony might have gained influence over the zone mapping of the use and protected areas of the national park. Also, the possibility of significant bribes for officials in the Ministry of Forestry could have been one of the reasons that the procedure for establishing the national park was shortened from nine steps to three.

The tentative agricultural loan program could be a solution for resolving conflicts over sand quarrying and the national park. However, since agricultural activities need fertilizers, pesticides, feed for dairy cows, and so on, international companies who sell such products may try to convince either the Republic of Indonesia or JBIC and JICA to increase the size of the loan that is offered.

Since access to funding to prevent deforestation was one of the justifications presented by the Governor of Yogyakarta for establishing the national park, the regional administration might have intentionally overlooked illegal sand-quarrying operations at some time during 1994-2001. This was because the more environmental impacts there were, the greater the funding provided to deal with deforestation would be.

4.13 A HOPE OBSERVED FROM STAKEHOLDERS' COALITION

Although the discussions on solution chains and secondary effects in the previous sections of this chapter have mainly been concerned with the technological trap of problematic chains that may never be resolved, the analysis of a coalition among stakeholders signals an optimistic possibility for escaping this trap. This section is devoted to the lesson to be learnt from the political phenomenon of a coalition among stakeholders in the solution chain.

Technological politics refers to the situation in which the use of technology transforms or orders people's decisions to choose a particular course of action without questioning or avoiding it. A solution chain, as a form of technological politics, influences many stakeholders to make decisions to cooperate with others. Analyzing such a coalition provides a lesson or message for the planners of future infrastructure developments.

It should be noted that a coalition can occur due to either the first or second notion of technological politics: who governs and what governs (see both figure 4-10 and table 4-3). As examples, with respect to the notion of who governs in coalition No.4, in establishing the Mt. Merapi National Park Plan there exists a coalition among the Central Government of the Republic of Indonesia (CG), the Regional Governmental Administrations (RA) and the international mining companies (MC). It is noted that the establishment of the national park plan introduced a new stakeholder – the international mining companies (MC) – into the solution chain (see stage [4-5: row2] in figure 4-10).

With respect to the notion of what governs in coalition No.5, the locals' anxiety regarding the possibilities of mass eviction and prohibitions on their usage of natural resources, which arose in response to the national park plan, forced farmers and other villagers (FV) and non-governmental organizations (NGOs) to cooperate with each other in arranging protests and lawsuits against the Ministry of Forestry. It is noted that this particular impact of the national park plan brought non-governmental organizations (NGOs) into the solution chain as a new stakeholder (see stage [4-5: row2] in figure 4-10).

Table 4-3: Stakeholders' Coalitions and Notions of Technological Politics

Coalition No.	New Stakeholder(s) Introduced into Chain	Inspiration for Coalition	Reason for Coalition's Dissolution
1	CG, JBIC, JICA, RA	Initial Project [*who governs*]	Construction Completion
-	FV	Initial Project [*who governs*]	-
2	PSC	License System [*who governs*]	-
-	LSN	Lack of Access to Sand [*what governs*]	-
1	-	Project Phase II [*who governs*]	-
3	-	GORO [*who governs*]	Principle-Agent Problem [*what governs*]
4	MC	National Park [*who governs*]	-
5	NGOs	Anxiety about Eviction, etc. [*what governs*]	Agricultural Loans [*who governs*]
1	-	Ex Post Evaluation [*who governs*]	-
6	-	Agricultural Loans [*who governs*]	Debt [*what governs*]
7	-	Debts [*what governs*]	-
-	MM, LL, FPC	Agricultural Loans [*who governs*]	-

The interesting point noted in this particular case study and that could be applicable in other future infrastructure development projects, is that it is possible to choose a solution that encourages the formation of a coalition among all or almost all of the conflicting stakeholders, such as a coalition between the central government and NGOs who would typically oppose each other. In this particular case study, for example, an agricultural loan program would encourage the formation of a coalition among conflicting stakeholders including the Central Government of the Republic of Indonesia (CG), JBIC, JICA, Regional Governmental Administrations (RA), farmers and other villagers (FV), the local sand miners (LSN), and non-governmental organizations (NGOs) (see stage [6-7] in figure 4-10).

Although the discussion in section 4.11 speculates that such a coalition could be dissolved later (i.e., at stage [7-8] in figure 4-10 due to a number of factors, especially the advantage-taking behaviors of new rent seekers), at least there exists the hope of a continuing coalition if the factors that would deteriorate such a coalition could be identified and eliminated in advance. A successful agricultural loan program could satisfy and unite the key conflicting stakeholders in the Sabo development project. This implies that the serious impacts of an infrastructure development could be resolved by encouraging the formation of a coalition among conflicting stakeholders by implementing an appropriate and well-prepared solution – for example, a solution in which the possibilities of advantage-taking behaviors on the part of both current and new stakeholders are identified and eliminated in advance.

4.14 SUMMARY

This chapter analyses a so-called 'successful' infrastructure development project in Indonesia. According to the analysis of the chains of solutions, it is difficult to agree that the project has been successful.

The technological imperatives of the Sabo dams, both structural and non-structural types, have led to the development of sand-quarrying activities; these have resulted in environmental destruction and social conflicts. These impacts have developed into a solution chain consisting of two early branches that then appear to converge into one. The interesting point of this case is that the implemented solutions have generated new impacts.

In the first branch of the chain, the establishment of the GORO Association not only was unable to resolve the impact on resource accessibility, but also increased the conflict into mob violence. In addition, the unexpected privileging of leaders and distrust among members occurred within the association. In the second branch of the solution chain, it is uncertain whether the national park can stop the destruction of forests that is arising from sand-quarrying activities, because the sand-mining areas of the large mining corporations are located in the use zone of the national park. While the success of the establishment of the national park remains unclear, yet another impact has arisen in the form of protests and lawsuits. Furthermore, the national park may also bring about the further impacts on massive illegal logging, the massive theft of biological resources, and the granting of legal permits for mining inside the park, as these impacts have occurred in national parks established previously in Indonesia.

Clearly, the two implemented solutions have not succeeded. Therefore, in the near future, the situation may require of further solutions for both the remaining impacts created by the Sabo dams and the new impacts created by previous solutions. The chain of solutions will continue.

During the development of the solution chain, certain actors may obtain or seek for opportunities for gain. As examples, the executive leaders of the GORO Association received special privileges from private sand-mining companies; the regional government proposed the national park plan in order to make gains from acquiring a regional status symbol, increased tourism, and deforestation funding; and international mining companies sought permits to mine in protected areas of the national park. These advantage-taking behaviors can be understood on the basis of concepts relating to non-neutral technological powers.

CHAPTER 5

CASE STUDY II: BANG PAKONG DIVERSION DAM (BPKD)

5.1 INTRODUCTION

The situation of non-functioning infrastructures, such as dams, is becoming more and more common nowadays. A non-functioning dam describes a dam on which construction has been completed, but for some reason its full operation cannot be started. This kind of infrastructure project is expected to have an extensive chain of solutions. The task of this chapter is to illustrate the chains of solutions associated with the Bang Pakong Diversion Dam project, a non-functioning dam in Thailand.

In some areas of the Bang Pakong Province in Thailand, water shortages affecting rice paddies and crops in the dry season are well known. These shortages occur for several main reasons, particularly the consumption of large amounts of water in upstream areas, and the intrusion of saline water from the Gulf of Thailand (see figure 5-1).

The Bang Pakong Diversion Dam Project (BPKD), planned as part of the agricultural water development project in the Bang Pakong River Basin, was constructed in Chachoengsao Province. The objectives of the project were to provide irrigation water for rice paddies and dry crops particularly in the dry season for an area of 92,000 rai (14,720 hectares), to make a reliable water supply available for local communities and industries, and to prevent the intrusion of saline water from the sea [JICA (1990), ONEP (2002), Chachoengsao (2006)].

The project consists of the following main facilities: a diversion dam, a diversion canal, a closure dam, a road, a road bridge, a pumping station, a control system and associated electrical facilities, operation and maintenance buildings, and irrigation canals.

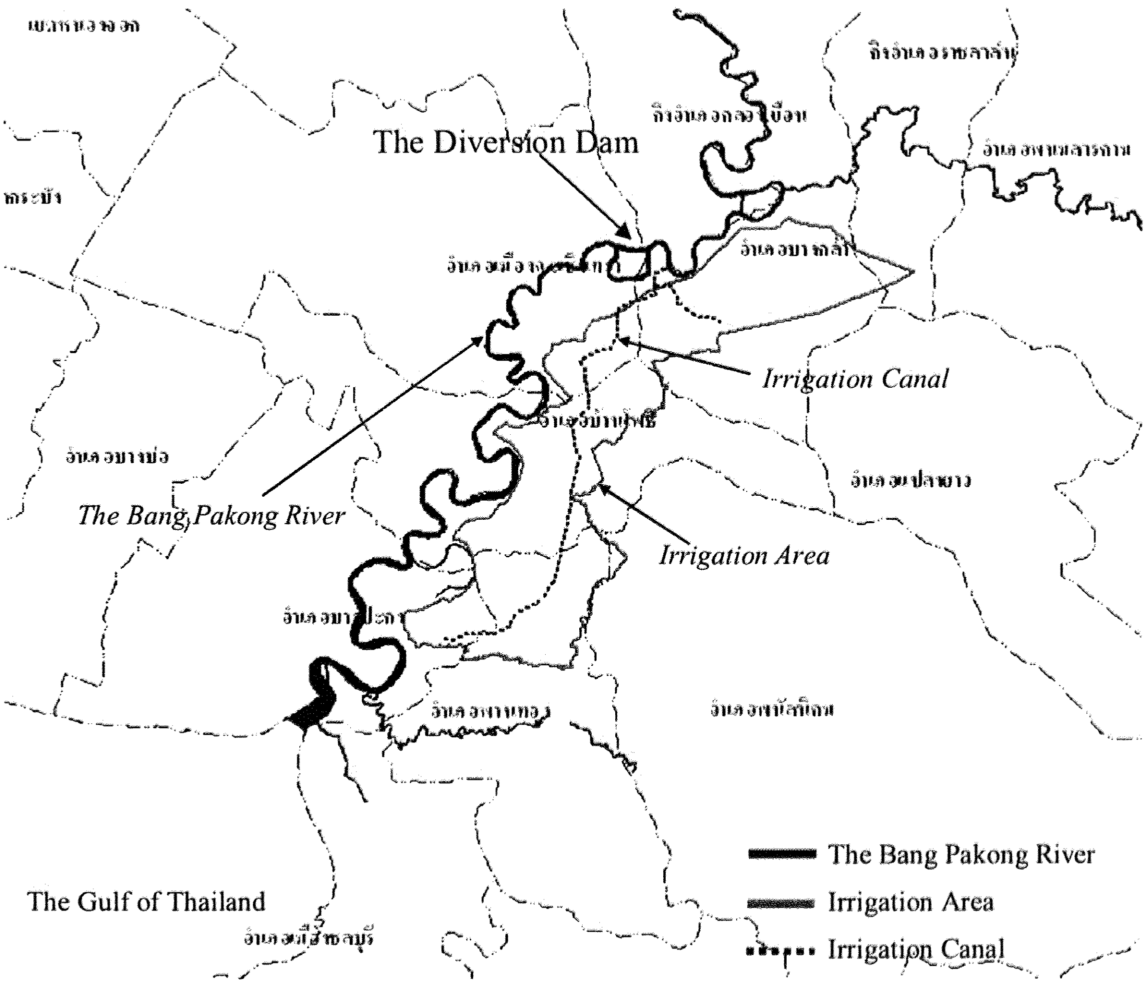
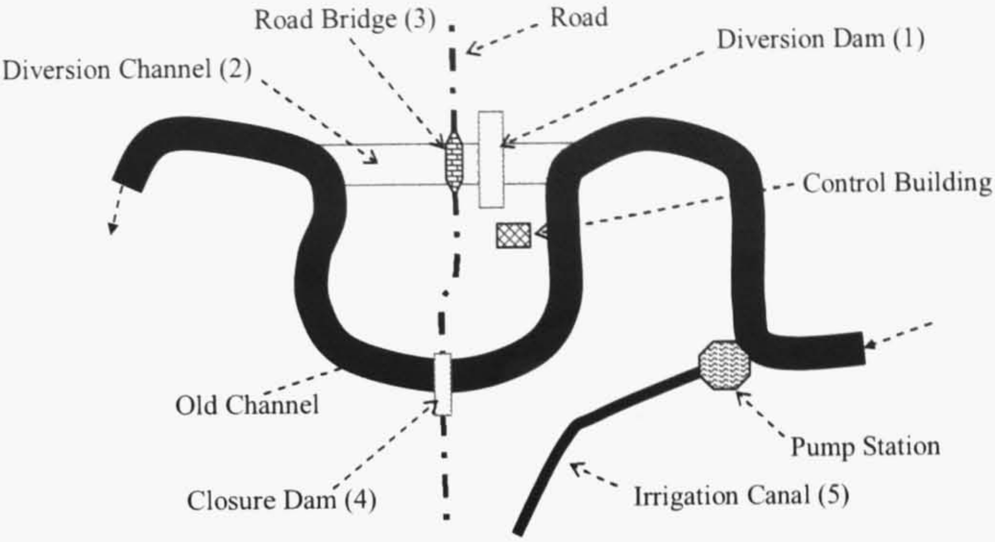
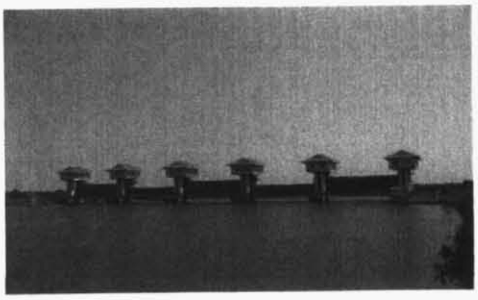


Figure 5-1: Location of the Bang Pakong Diversion Dam Project
(Source: ONEP, 2002)

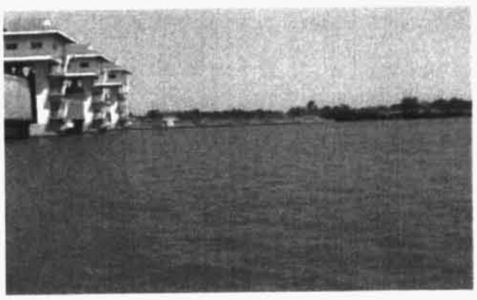
The 166-meter-long Bang Pakong Diversion Dam is located 70 kilometers from the Gulf of Thailand. The dam was constructed on a new diversion channel during the period from October 1996 to December 1999. The new diversion channel is 2.2 kilometers long, and its bed is 105 meters wide. A closure dam was constructed on the old channel; the closure dam was 16 meters high, 12 meters wide, and 280 meters long at its crest. The road is 2.7 kilometers long. The road bridge is 13 meters wide and





Diversion Dam (1)

Diversion Dam, a close look (1)



Diversion Channel (2)

Road Bridge (3)

Closure Dam (4) (ONEP, 2002)

Irrigation Canal (5)

Figure 5-2: Main Components of the Bang Pakong Diversion Dam Project approximately 226 meters long. The pumping station has a pump-discharge capacity of 16 cubic meters per second. The control system consists of a remote control system for the tide protection gates and pumps, an ITV monitoring system, electrical substations, distribution lines, and so forth. The operation and maintenance buildings are located near the diversion dam. The irrigation canals consist of a 28.9-kilometer-long main canal and a 4.5-kilometer-long left-side canal [JICA (1993), ONEP (2002)] (see figure 5-2).

The initial contracted cost of the project, excluding the irrigation canal, was 1,970 million baht [Chachoengsao, 2006]. However, from 1993 to 1999, the project has expended a budget of 2,748 million baht [ONEP, 2002].

The construction of the main components of the BPKD project was completed in December 1999. At that time, its operation tests were implemented. However, immediately following the tests, a number of negative impacts occurred that were so significant that the dam's operation was suspended [SEARIN (2001), SEARIN (2002a), Changyawa (2002)]. As a result, the duration for the completion of the project was extended from 9 years (1993-2001) to 14 years (1993-2006) [Changyawa (2002)]. Between 2000 and 2006, many efforts have been made to render the project operational. Recently, in early 2006, operation tests were resumed with the hope of launching the dam's continuous operation, but the success of the tests is still unclear. The following sections tell the project's story.

5.2 NEGATIVE IMPACTS

There have been five main unexpected negative impacts which have occurred as a result of the operation of the dam. The first three impacts were reported in the media and in official reports. The last two were identified during a field survey.

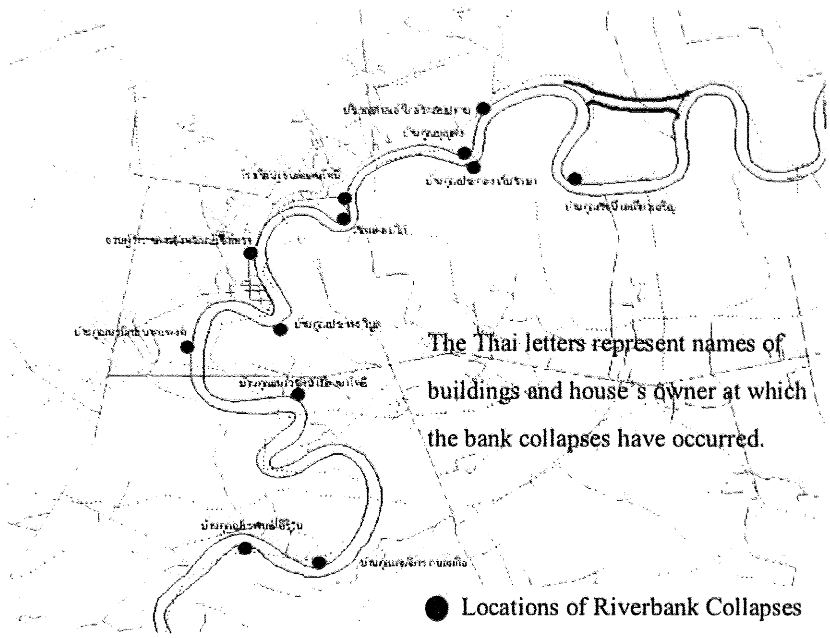


Figure 5-3: Locations of Bank Collapses
(Source: ONEP, 2002)

During its operation tests on 26-27 August 1999 and on 6 January – 20 April 2000, two unexpected negative impacts occurred immediately due to wave resonance [ONEP, 2002]. The wave resonance effect created new highest and lowest water levels which were 0.7 meters greater than the natural highest and lowest water levels [ONEP, 2002]. The first impact of this effect involved a series of sudden collapses of the riverbank at 12 locations downstream, which resulted in 5.0 million baht worth of reconstruction work [ONEP, 2002]. The second impact involved severe saltwater flooding downstream along sections of riverbank totaling 79.85 kilometers in length [ONEP, 2002]. The flood depth ranged from 0.10 to 0.90 meters [ONEP, 2002]. Figures 5-3 and 5-4 show the locations of the bank erosions and flooding, respectively.

Third, the quality of water was found to be degraded at several locations such as in the old river channel and in the natural canals upstream of the dam. This has occurred for several main reasons [ONEP, 2002]. Firstly, the closure dam traps water-borne wastes and causes the water to flow at a lower speed in the river, which results in the pollution-carrying capacity of the river being reduced [ONEP, 2002]. Secondly, untreated wastewater was discharged into the river by many sectors; these included households, industries, shrimp farms, pig farms, and other agricultural facilities [ONEP, 2002]. Thirdly, the pollution load in the Bang Pakong River had almost reached its capacity before the construction of the dam [ONEP, 2002]. Accordingly, within a few months of the completion of the closure dam, the water was exhibiting changes in both color and smell, in both the old channel and its tributaries (see figure 5-5).

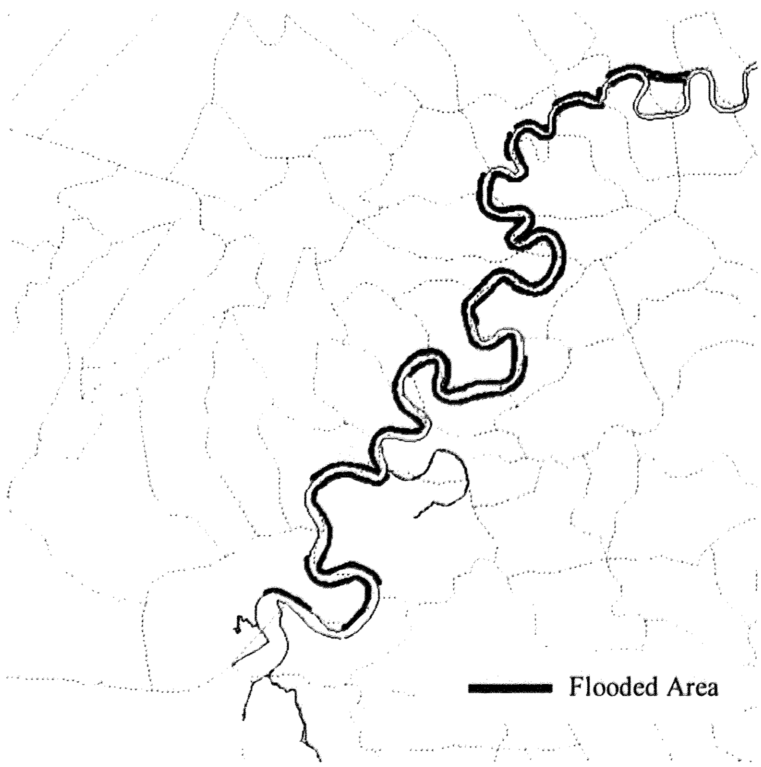
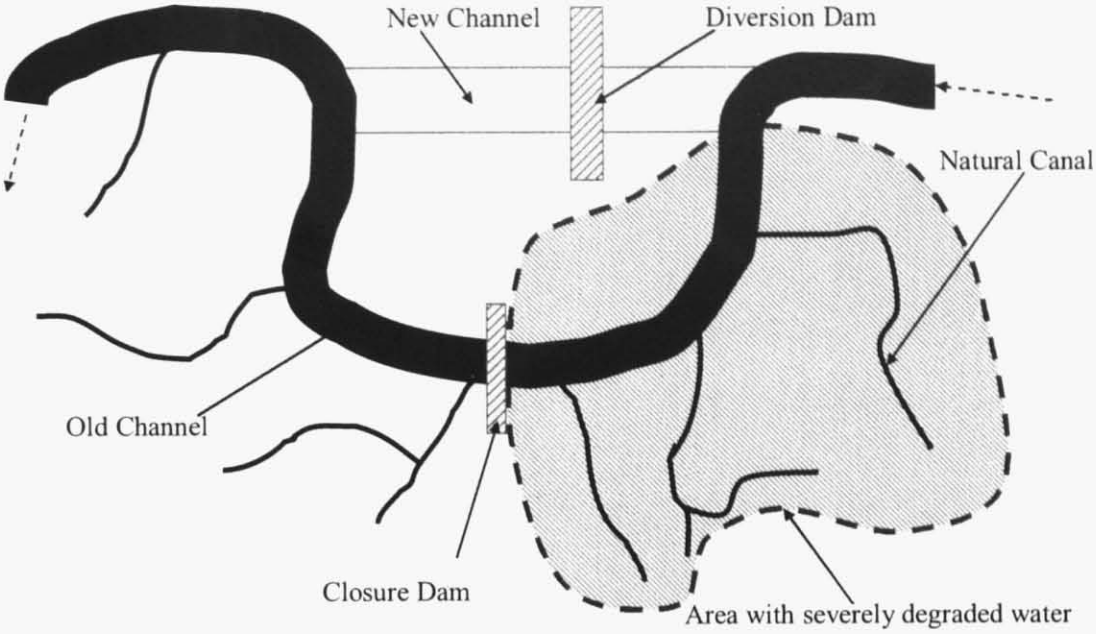


Figure 5-4: Locations of Flooding
(Source: ONEP, 2002)

As a fourth impact of the dam's operation, other instances of degraded water quality have been found at the crossings between the irrigation and natural canals. Geographically, the Bang Pakong River has many tributaries that form small natural canals. These natural canals have interconnected into a canal network, particularly in



Degraded Water in Natural Canal

Degraded Water at Closure Dam

Degraded Water in Natural Canal

Figure 5-5: Degraded Water in River and Natural Canals Upstream from Dam

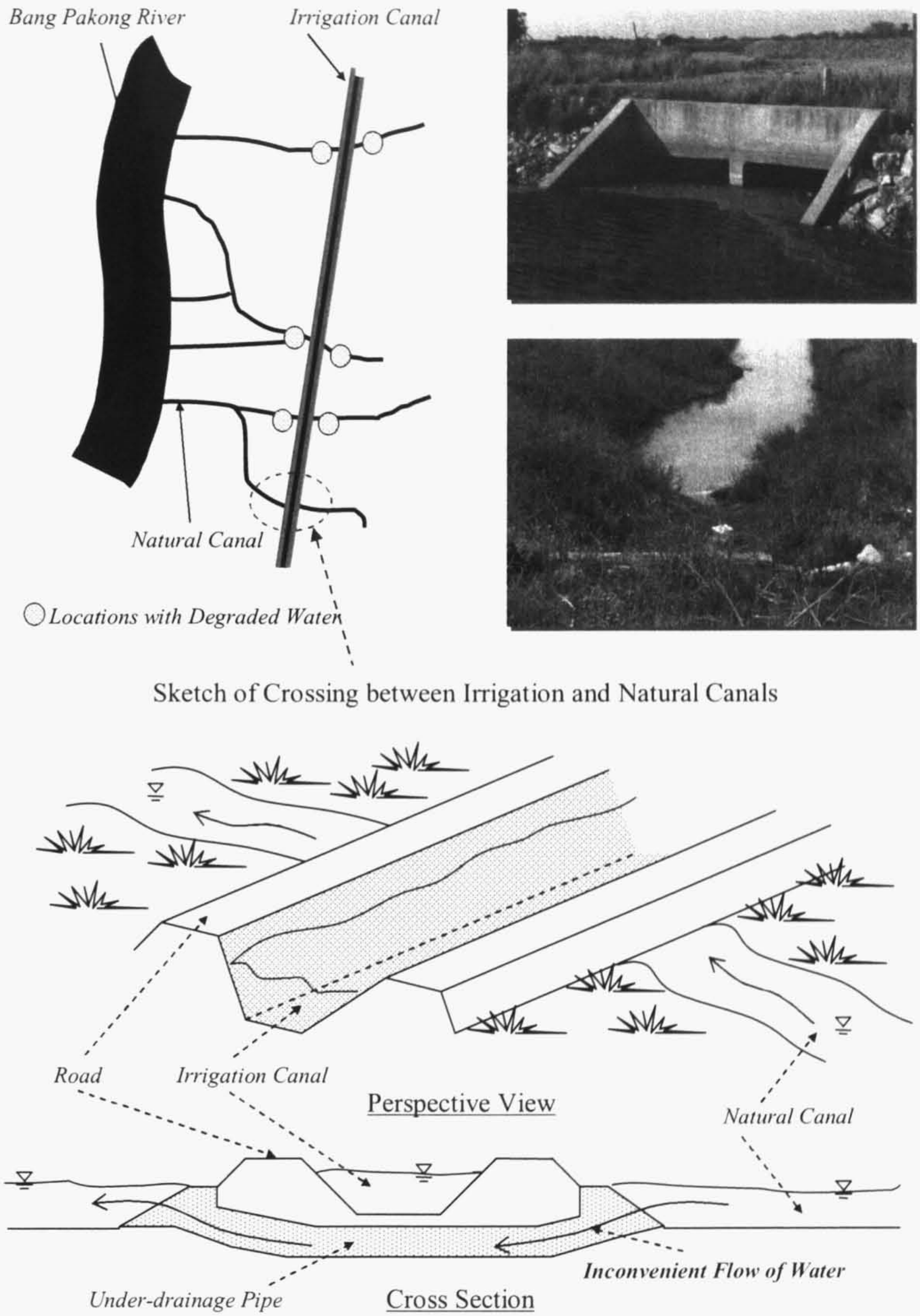


Figure 5-6: Degraded Water at Crossings between Irrigation and Natural Canals

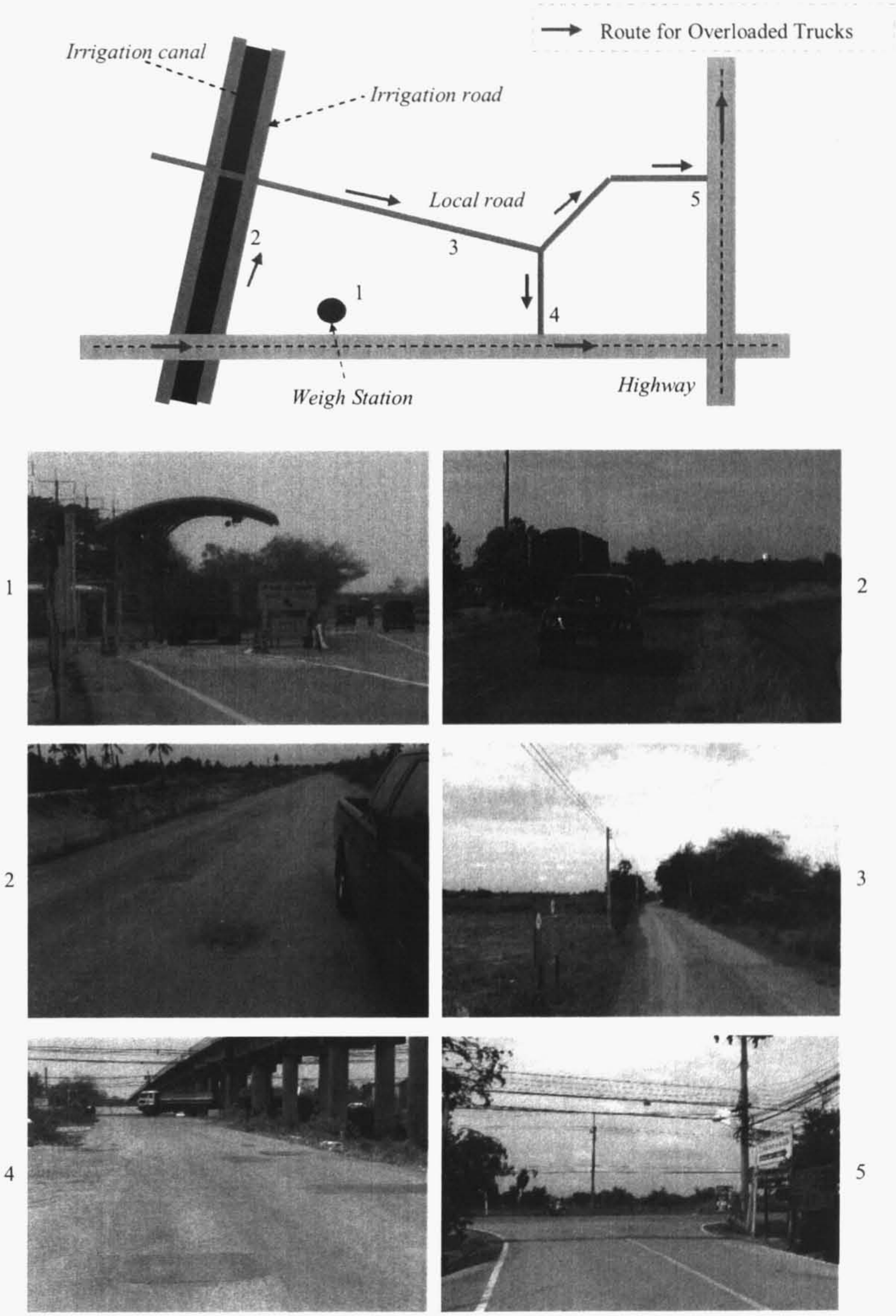


Figure 5-7: Weigh Station Avoidance Route for Overloaded Trucks

rural areas. Traditionally, the locals use water from these natural canals for various activities. However, the irrigation canal was constructed in such a way that it splits the network of natural canals. At the crossings, the irrigation canal was constructed over the natural canal, and thus an under-drainage pipe was necessary at most crossings (see figure 5-6). However, this under-drainage pipe slows down the water flow in the natural canals on both sides of the irrigation canal. Accordingly, the water condition has become degraded.

The fifth impact resulting from the dam's operation was seen recently when overloaded trucks began using the access roads for the irrigation canals in order to avoid a weigh station located on a nearby highway. Chachoengsao Province is located between Bangkok and the eastern part of Thailand. Numerous trucks carrying goods and products travel daily between Bangkok and the eastern part of Thailand through this province. Many of these trucks carry loads of goods and products that are larger than what is permitted by law, and thus they cause damage to the road surfaces and structure. Accordingly, many weigh stations have been set up on the main highways along the routes between Bangkok and the eastern part of Thailand. The main irrigation canal for the dam intersects with a highway, and thus the road along the irrigation canal becomes a connecting route between the highway and the existing local road. This route is used by overloaded trucks to avoid a weigh station located on the highway (see figure 5-7).

5.3 TECHNOLOGICAL POWERS EMBEDDED IN THE PROJECT

A number of concepts related to the non-neutral powers of technology are helpful in identifying these five impacts. The notion of unforeseeable effects is one of the ambiguities of technology mentioned by Ellul (1962). He described the unseen linkage between the chemical substance of DDT and babies' health. The DDT was used in cleaning the skin of cattle, and thus the chemical substance was transferred into their milk. Babies then received the chemical substance through drinking milk daily. This is an unseen linkage between cause and effect which was not predicted at that time. Typically, a dam causes flooding upstream from its location. In the case of the BPKD, the bank erosions and saltwater flooding which occurred downstream were similarly unexpected. Their possible linkages with the diversion dam were not foreseen at the time of project planning and impact assessment (see figure 5-8).

Tenner (1996) points out that many technologies have revenge effects on users instead of achieving their objectives. For example, electronic mails and documents, designed to eliminate paperwork, result in office recycling bins overflowing with printouts. While designed to provide a reliable water supply, the BPKD project has resulted in the degradation of water quality in many locations. Considering this concept during the project planning phase may have helped to decreasing the number of revenge-effect-type impacts.

The concept of technological imperatives proposed by Winner (1977) has proved relevant again. The access road for the irrigation canal is causing a significant impact. In addition to its intended purpose, the road opens up the possibility of various kinds of usage. In this case, overloaded trucks can use it to avoid a weigh station located on a nearby highway. As noted in a critique by Pinch and Bijker (1987), technology holds the quality of flexibility of interpretation. Its meanings depend on its users' interpretations. This is also a good example of Marcuse's notion (1964) that a technology creates difficulty in separating good from bad.

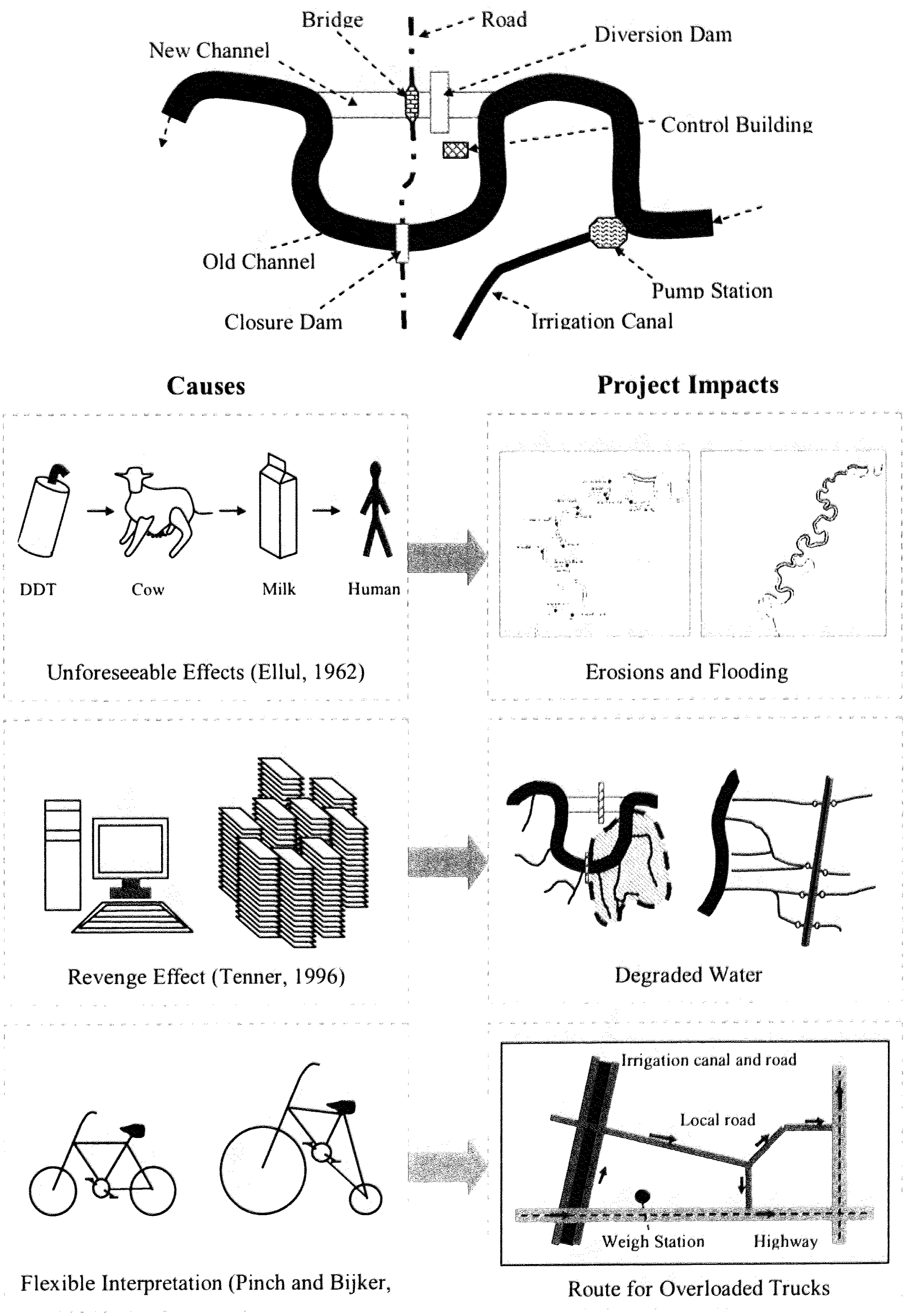


Figure 5-8: Technological Concepts Clarifying Project Impacts

5.4 SOLUTIONS

Several solutions have been implemented in order to resolve these impacts. For the impact on erosion and flooding, the solutions have been the construction of bank flood-prevention structures and a new operation rule for the diversion dam. For the impact on degraded water quality, the solutions have included a new regulation governing wastewater standards for pig-farming, the construction of a wastewater treatment system for the pig farms, the construction of new flood gates at the closure dam, and design changes at the crossings between the irrigation and natural canals. The impact on overloaded trucks has only recently arisen, so that no solution has been implemented to date. The details of each of these solutions are described in the following.

After the completion of the diversion dam in December 1999, the first three impacts were significant enough to have prompted the suspension of dam operations, as well as a request for urgent corrective actions from the Royal Irrigation Department and the Thai government. On 28 January 2002, the Thai Prime Minister paid a visit to the dam site to gain a more detailed understanding of the impacts [SEARIN (2002a), SEARIN (2002b), SEARIN (2002c)].

Between February 2001 and August 2002, a comprehensive ex post evaluation was undertaken to investigate these three impacts as well as others, with a budget of 22.3 million baht [The PTC website]. As a result, numerous corrective, preventive and monitoring actions were proposed (see table 5-1).

In the 2002 ex post evaluation report, three alternative sets of solutions were analyzed, and the second set was recommended. This set of solutions involves decreasing the influence of the wave resonance by adjusting the operation rule of the diversion dam in such a way that, relative to the average water-level of the river, the highest water level is not higher than 1.70 meters and the lowest is not lower than 1.05 meters (+1.70/-1.05). In addition, the construction of 5.9-kilometer-long and 67.6-kilometer-long structures was proposed for the prevention of erosions and flooding, respectively. The estimated cost of these structures was 668,916,400 baht, and the total estimated budget for this set of solutions was 854,842,400 baht. [ONEP, 2002] Later, this report was used as a basis for further decisions by responsible agencies such as the Royal Irrigation Department (RID) and the Pollution Control Department (PCD).

Table 5-1: Corrective, Preventive and Monitoring Actions

No	Solution	Budget (Baht)	Alternative		
			1st	2nd	3rd
Immediate Actions					
1.1	Public education about impacts of the dam	850,000	O	O	O
1.2	Public participation promotion	329,000	O	O	O
1.3	Determination of shrimp-farming zone	1,185,000		O	O
1.4	Adjustment of dam operation rule	*		O	
1.5	Impact correctives & prevention at the closure dam	36,109,000	O	O	O
1.6	Flooding and erosion corrective & prevention structures	1st: 1,127,687,000 2nd: 668,916,400	O	O	
Actions for Promoting Good Environment Quality					
2.1	Determination of standard pig-farming practices	600,000	O	O	O
2.2	Public education about good shrimp-farming practices	3,020,000	O	O	O
2.3	Agricultural promotion of irrigated areas	1,720,000	O	O	
2.4	Improvement of industrial wastewater discharge	**	O	O	O
2.5	Determination of water allocation plan	5,450,000	O	O	O
2.6	Natural resources school project	3,135,000	O	O	O
2.7	Promoting tourism at the dam site	2,046,000	O	O	O
Monitoring Actions for Maintaining Good Environment Quality					
3.1	Watchdog volunteers for industrial pollution	282,000	O	O	O
3.2	Protecting the hometown	88,800,000	O	O	O
3.3	Resources and environment quality change monitoring	42,400,000	O	O	O
Summary of Budget					
Alternative 1		1,312,428,000			
Alternative 2		854,842,400			
Alternative 3		184,206,000			

Note:
* The budget for action 1.4 is included in the budget for action 1.6
** Uses regular government budget
Alternative 1: As-designed operation; Alternative 2: Adjusted operation; Alternative 3: Delayed operation.
Most actions were planned to start in 2003.

Source with modification: ONEP (2002)

In Thailand, pig farming has been causing water to be polluted and unpleasant smelling for decades. In some provinces, there have been serious conflicts between pig farmers and the locals. The conflict has increased in particular since the pig farming industry has expanded in scale. On 23 February 2001, as an attempt to improve pig farming practices, a new Effluent Standard for Pig Farms was announced, with the effective date of enforcement for large and middle scale farms being 24 February 2002 [PCD (2003), PCD (2006)].

There are a great number of pig farms or piggeries in Chachoengsao Province. From the total numbers of more than 1,700 piggeries with around 850,000 pigs in the province, more than 170 piggeries housing more than 200,000 pigs are located in the vicinity of the river and its tributaries [PCD, 2003]. Importantly, the wastewater from these pig farms pollutes water in natural canals and the river [ONEP, 2002]. Because of its wastewater impact, created partly by the BPKD project and pig farming, Chachoengsao Province was selected as one of two areas for a pilot study implementing the new Effluent Standard for Pig Farms, and thus the province gained subsidies for constructing wastewater treatment systems [DLD, No date].

Therefore, during 2001 and 2002, wastewater treatment systems were constructed with a subsidy of 50% of the construction costs on 218 pig farms who volunteered to participate in the study. The subsidized construction costs ranged from 20,000 to 100,000 baht per farm depending on the size of the farm and the type of treatment [PCD (2003), PCD (2004), DLD (no date)]. There are four standard types of wastewater treatment system [PCD (2003), DLD (no date)]. The first type involves an anaerobic filter tank and has a wastewater capacity of not more than 5 cubic meters per day and a pig population of not more than 250 pigs. It requires a construction area of 220 square meters, and the subsidy is 20,000 baht per farm. The second type involves a stabilization pond and has a wastewater capacity of not more than 10 cubic meters per day and a pig population of not more than 500 pigs. It requires a construction area of 1,000 square meters, and the subsidy is 40,000 baht per farm. The third type involves an anaerobic filter tank and has a wastewater capacity of not more than 10 cubic meters per day and a pig population of not more than 500 pigs. It requires a construction area of 450 square meters, and the subsidy is 40,000 baht per farm. The fourth type involves a stabilization pond and has a wastewater capacity of not more than 30 cubic meters per day and a pig population of not more than 2,000 pigs. It requires a construction area of 2,200 square meters, and the subsidy is 100,000 baht per farm.

However, the wastewater treatment systems installed on the pig farms did not function properly in most cases. The difficulties encountered included an insufficient construction area, an inappropriate shape for the area, and poor soil quality [PCD, 2003]. These difficulties lead to an attempt in 2003 by PCD to hire a consultant company to perform a detailed analysis as a basis for making recommendations regarding corrective actions [PCD, 2003]. Unfortunately, according to the results of water samplings taken at the end of the consulting task, it was found that the quality of the discharged wastewater satisfied the requirements of the new Effluent Standard in only 20% of farms [PCD, 2003].

In the 2003 study of the implementation plan for mitigating impacts of the BPKD project conducted by the Royal Irrigation Department (RID), the RID proposed a new adjusted operation rule (+1.35/-1.05) that involved setting the sluice gates for half-closed instead of full-closed operation. Under this new operation rule, the dam is operational only for the 3 month period from December to February, which is the period during which the intrusion of saltwater usually occurs – under the original operation rule the dam was operational for 5 months. For the rest of year (9 months), the gates are fully opened so that the water in the river is regular brackish river water. Also, under this operation rule, the highest and lowest water levels are the same as those under the natural conditions of the river; therefore, it is not necessary to construct prevention structures for erosions and flooding that would occur with an increase in wave resonance [RID (2003), RID (2004)].

However, the RID recommended that prevention structures should be constructed to prevent erosions and flooding that occurred naturally so that any possible public misunderstanding about the impacts of the dam can be completely eliminated. The estimated cost of the structures was 321.8 million baht. In addition, the RID put forward a suggestion that better structures be constructed with an additional 0.15 meter in height, meaning an additional cost of 41.6 million baht. Accordingly, a plan with a total estimated cost of 363.4 million baht was proposed for the construction of the 5.5-kilometer-long erosion prevention structure (259.9 million baht), the 39.6-kilometer-long flooding prevention structure (88.1 million baht), and the erosion monitoring system (15.4 million baht). [RID, 2003]

Furthermore, the new operation rule demands the following additional requirements: upgrading of the sluice gates at the diversion dam to allow more flexible operation (11.0 million baht), upgrading the water-pump station to cope with brackish water (55.0 million baht), constructing or restoring 15 hydrological stations along the river with a central automatic control system (59.4 million baht), and releasing 130 million cubic meters of capital water from two upper dams – the Klong-Tha-Daan Dam and the Klong-Sri-Yad Dam. These requirements will necessitate an additional investment of 125.0 million baht. Thus, the total estimated cost was 488.0 million baht [RID (2003), RID (2004)].

In the same study, to tackle the impact of degraded water quality, two corrective actions were proposed. First, three flood gates would be installed at the closure dam to increase the water flow in the river from 2.5 to 100 cubic meters per second. The size of each flood gate would be 6 x 4.5 meters, and their estimated cost is 92 miilion baht; this would mean a budget increase from the 36.1 million baht estimated in the ex post evaluation study carried out by ONEP in 2002 [RID (2003), RID (2004)].

Second, the installation of some water-circulation pumps was planned for six locations in the estuary of the natural canals and in the old river channel. Four are upstream of the dam, and two are downstream. Of the upstream ones, three are in the estuaries of Klong Sa-Dao, Klong Soen-Yai, and Klong Juk-Chur-Bon, and one is adjacent to the closure dam. Of the downstream ones, one is adjacent to the closure dam, and the other is in the estuary of Klong Juk-Chur-Lang. The estimated cost was 7.0 million baht. [RID (2003), RID (2004)]

Table 5-2: Proposed Expenditures in the RID 2003 Implementation Study

No.	Items	Budget (baht)
1	Public Relations	2,000,000
2	Installation of 3 gates at closure dam and 6 water-circulation pumps	99,000,000
3	Upgrading of flood gates at main dam	11,000,000
4	15 hydrological stations: 9 new, 6 restored	59,400,000
5	Prevention structures for erosion (5.555 kilometers)	259,919,000
6	Prevention structures for flooding (39.64 kilometers)	88,132,000
7	Construction of Erosion Monitoring System	15,400,000
8	Upgrading water-pump stations for coping with brackish water	55,000,000
9	Landscape improvements for promotion of tourism and public understanding	27,000,000
	Total	616,851,000
Note: all items are expenditures that will be the responsibility of the RID for actual implementation		

Source: RID (2003)

Moreover, in the same study, the RID proposed two further tasks: public relations, and landscape improvements for the promotion of tourism and public understanding. Their estimated costs were 2.0 and 27.0 million baht, respectively. Table 5-2 summarizes the estimated expenditures for the tasks proposed by the RID in their 2003 implementation study. The total proposed budget was 616.8 million baht.

On 13 November 2003, the construction of the three additional flood gates at the closure dam was started, with a contracted completion date of 6 November 2004. According to the public notification of construction, the actual bidding price was 68.6 million baht.

In November 2003, the 2003 implementation study was put forward for Cabinet approval, but it was rejected because of the high cost. In that meeting, the Thai Prime Minister commented that only the essential actions should be implemented, otherwise the complete decommissioning of the dam should be considered. Subsequently, the proposal was revised in such a way that five items were excluded and three were added. The final plan approved by the Cabinet includes implementing the new operation rule with its three associated requirements; upgrading the sluice gates at the diversion dam, constructing or restoring 14 hydrological stations (instead of 15 hydrological stations), and releasing 130 million cubic meters of capital water from two upper dams. The estimated cost of these requirements was 67.0 million baht. The total estimated expenditure was 96.3 million baht. [RID, 2004] Table 5-3 shows the approved items of expenditure for implementation.

Table 5-3: Approved Items of Expenditure for Implementation

No.	Items	Budget (baht)
1	14 hydrological stations: 8 new, 6 restored	56,000,000
2	Upgrading flood gates at main dam	11,000,000
3	6 water-circulation pumps	7,000,000
4	Installation of hydrological reference points downstream	900,000
5	Brackish Water Ecology Study in the Bang Pakong River	10,480,000
6	Public Relations	2,000,000
7	Administrative work	9,000,000
	Total	96,380,000

Source: RID (2004)

The new operation rule was tested from December 2005 to January 2006, and there were no reports of erosion or flooding. It appears that the impacts have been resolved. However, it should be noted that the impacts were solved at the expense of decreasing the capacity of the dam.

According to interviews with sub-district leaders, the locals were concerned that the water flow in the natural canals would be disrupted by the structure of the irrigation canal. Therefore, they requested that the RID increase the size of the under-drainage pipes at several of the crossings between the irrigation and natural canals. According to an interview with an RID official, some of these crossings have been constructed according to a new design, while others are undergoing design changes. As of March 2006, more than 90% of the total length of the irrigation canals has been completed. The remaining portions are incomplete for various reasons; these include some remaining design changes at the crossings, and an expropriation difficulty. However, at several of the crossings where re-design work has been completed, the degradation of the water quality is still apparent.

As of March 2006, the construction of the three additional flood gates at the closure dam has not yet been completed. According to an interview with an RID official, the construction is expected to be completed in August 2006. However, according to interviews with sub-district leaders in March 2006, there is no confidence that the three new flood gates will solve the impacts. The leaders and villagers believe that the water flow in the old channel will not be significantly improved, because of the strong hydrological influence of the water flow in the new diversion channel.