4.0 UNINTENDED CONSEQUENCES

Environmental protection programs are often developed and implemented without consideration of the cost of treatment versus the environmental benefit achieved. This approach can be necessary in many circumstances where concerns exist regarding protection of human health and the environment. However, after basic levels of pollution reduction have been achieved using best available technologies, the cost of additional pollution reduction can be significant.

As is discussed in more detail in the next chapter, WWTPs discharging to dry riverbeds or intermittent waters often must meet effluent quality limitations at the "end-of-the-pipe." This approach contrasts with effluent discharges to perennial waters where the effluent is allowed to mix with or be diluted by in-stream waters, resulting in less stringent effluent quality requirements and lower treatment costs for these facilities.

At the same time that treatment costs for facilities that create effluent-dependent waters have risen, the value of water in the arid West has also increased substantially. In fact, not only has the cost of non-potable water risen, but so has the value of treated effluent, which is increasingly being used as an alternative water source for non-potable water needs. The result is an increasingly complex relationship among the cost of treatment, value of water, and value of treated effluent.

Superimposed on treatment costs and water resource values are two additional issues: environmental benefits achieved versus the cost of treatment and ownership of water in the arid West. The following sections discuss some of these complexities in more detail with a focus on how water ownership and the value of water can drive decisions that can have unintended consequences from the perspective of environmental protection. It is important that these complexities be understood because they have significant bearing on the implementation of environmental protection programs in effluent-dependent waters.

4.1 WESTERN WATER RIGHTS

Because water is scarce, water rights play a significant role in the management of water quality in the arid West. The importance of water rights was recognized in the 1972 Clean Water Act, which included a provision stating that the jurisdiction of each state over the allocation of quantities of water within its boundaries was not superseded or abrogated by the Clean Water Act (Section 101(g) of the Act).

Section 101(g) of the Act applies nationally; however, the establishment and implementation of water rights law varies significantly between the eastern and western

Section 101(g), Clean Water Act

It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water that have been established by any state. Federal agencies shall cooperate with state and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.

portions of the United States. Consequently, the significance of Section 101(g) of the Act varies between the arid West and other parts of the country.

Water rights law has followed along two distinct and different pathways in the United States. In the eastern or more mesic regions of the United States, water rights law typically adheres to the *"Principle of Riparianism,"* which assumes that water is available to all riparian or littoral property owners (i.e., property owners along a stream or lake). Under this system, unless a use of water by one entity could reasonably interfere with the use of water by another entity, all uses for water, historical as well as current, are allowed. This system works fairly well when water is plentiful; however, if water resources decline (e.g., as a result of drought), then determining whether one use reasonably interferes with another use becomes increasingly difficult to ascertain.

In the West, especially the arid West, water rights are typically governed by the *"Doctrine of Prior Appropriation."* This approach to water rights is based on land ownership and the principle of "first in time, first in right," meaning that the first claim in time retains its claim to the use of the water. For example, a farm that obtained a water right from the state in 1920 would have priority over a municipality that obtained its water right from the same waterbody in 1940. If during times of drought water quantity becomes limited, the farm as the senior appropriator has the right to claim its water before the municipality. Also, very importantly, because the farm "owns" the water because of its prior appropriation, the farm can sell or lease all or part of its water right to the municipality. As a result of the system of prior appropriation, ownership of a water right is a valuable commodity that can be sold, leased, or traded in a manner similar to any other commodity.

In the West, the ownership of water is held by the state until the water is appropriated. As water flows in a waterbody it remains under the ownership of the state until the owner of the water right takes the water into possession. It is at this point of transfer that water becomes the personal property of the owner and the owner has the right to use the water or sell/lease the water to another user. Under this scenario, as a WWTP receives influent into its sewage collection system, ownership of the associated water transfers to the owner of the WWTP, and once this influent is treated as required by regulation, use of the treated effluent is at the discretion of the facility owner. Treated effluent, then, is a commodity that has a market value, value that can increase with higher levels of treatment.

4.2 EFFLUENT QUALITY AND THE VALUE OF WATER

According to regulations established at Title 40 Code of Federal Regulations (CFR) 131, water quality criteria must fully protect the designated beneficial uses of each waterbody. In addition, per requirements of 40 CFR 122, NPDES permit limits must be implemented to ensure that the receiving water quality consistently complies with the applicable criteria. Unless exempted by a detailed site-specific analysis, all surface waters under the jurisdiction of the Clean Water Act are expected to support an aquatic life beneficial use.

Some states refine their use classification system to identify specific categories and subcategories of aquatic life. For example, many states distinguish between a coldwater and a warmwater fishery. Others draw a distinction between streams that support sport fish (bass, trout) and waters that support primarily non-game fish (minnows, suckers, chubs). Rarely, however, do most states develop separate water quality criteria for each aquatic life category or subcategory. Instead, stream standards are the same regardless of the aquatic life category or subcategory and in many states these standards are the same as federally recommended criteria for the protection of all aquatic species including coldwater fish.

Unless site-specific (e.g., for a particular stream), or waterbody-type specific (e.g., warmwater stream) water quality criteria are developed, EPA believes that their default standards published in guidance are protective of a waterbody designated with an aquatic life use. Moreover, these standards are assumed to be appropriate regardless of whether the stream is composed primarily of natural flows or is effluent-dependent. As a result, permitted discharges typically are expected to meet the same water quality standards regardless of the stream conditions prior to discharge. In the federal guidance, there is no special consideration given for hydrating an otherwise dry wash or creating riparian habitat where none existed before.

However, as noted above, one of the key attributes of water in the West is its value, and increased competition for water resources, a result of substantial population growth, places increased value on this water. At the same time, requirements for meeting water quality standards to protect in-stream uses, especially aquatic life uses, have increased substantially, and increased treatment costs required to meet these standards have increased the incentive to sell or lease effluent to recoup some of this increased treatment cost. The result has been the diversion of wastewater flows away from natural stream channels, and initiatives designed to improve water quality may, ultimately, cause the loss of aquatic habitat that the regulations were designed to protect.

Because freshwater is a scarce commodity in the arid West, competition for this resource increases as populations grow throughout the region. Many of the largest cities in Arizona, New Mexico, Nevada, Colorado, Texas, and California find it increasingly difficult to secure the permanent right for adequate freshwater supplies to meet anticipated demand. Naturally, as the problem grows more acute, interest in water recycling also intensifies.

Until recently, the primary limitations on reclaimed water projects were the general lack of public acceptance and the total cost of distribution infrastructure. Historically, it has always been cheaper and easier to "treat and discharge" than to recycle municipal effluent. However, several factors are now combining to challenge the economic foundations of traditional wastewater disposal strategies as follows:

- The available supply of freshwater resources is being outstripped by population growth. In addition, environmental concerns frequently preclude municipalities from transferring water from other jurisdictions. In particular, several significant water rights cases have radically altered the allocation to each state from major rivers flowing through the western United States.

- The relative scarcity of new freshwater resources has caused the price of that resource to rise dramatically. The historical cost advantage that freshwater has enjoyed over reclaimed water is rapidly eroding.

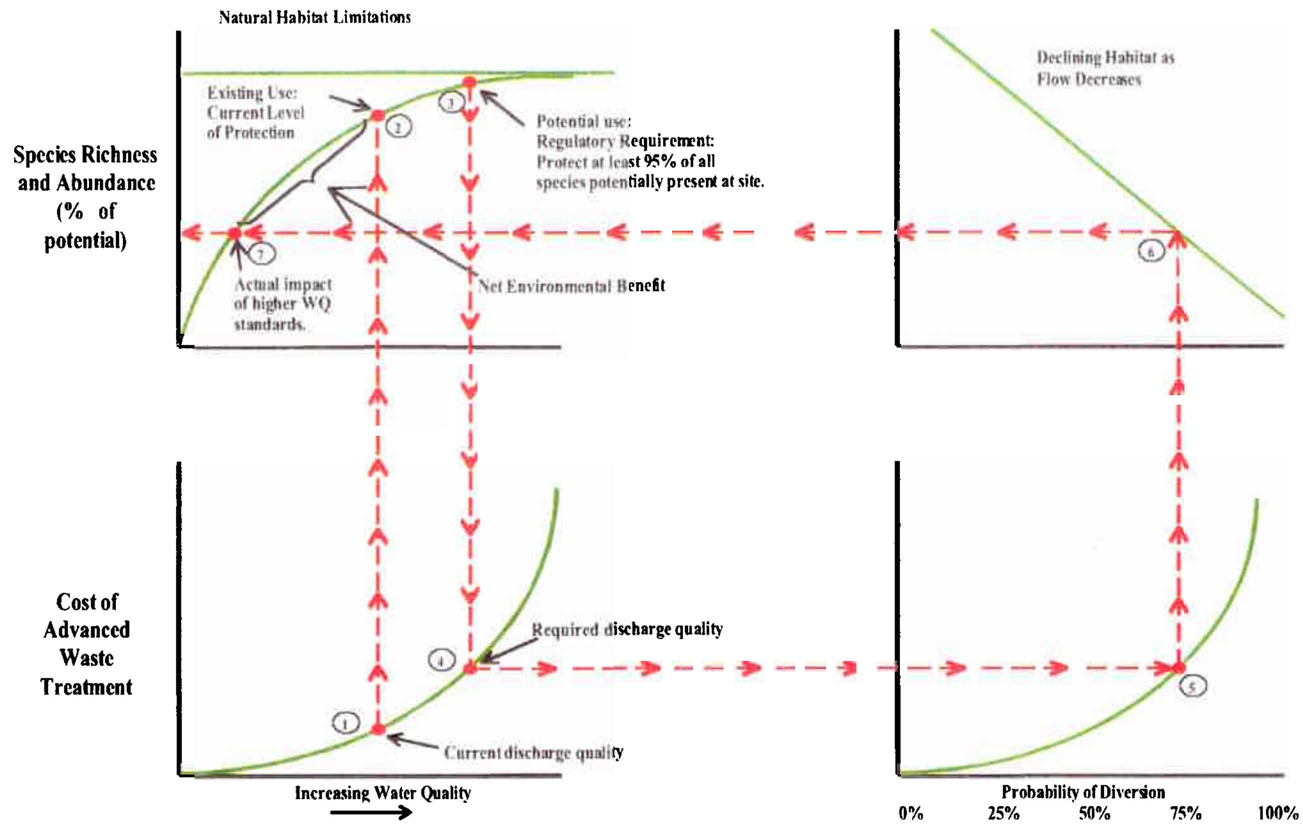
- The level of treatment required to continue discharging municipal effluent into natural streambeds is also continuing to climb. Water quality-based permit limits have caused most cities to construct advanced wastewater treatment systems designed to reduce the concentrations of ammonia, pathogens, and chlorine. New regulatory initiatives may require additional treatment to control pesticides, surfactants, total organic carbon, trace metals, and total dissolved solids. Added costs encourage permittees to develop more creative strategies to ensure long-term compliance with the Clean Water Act. Among the alternatives most frequently considered is increased water reclamation and reuse. By definition, this alternative implies reducing the amount of effluent discharged to local streams and washes.

A regulatory dilemma arises when one considers what level of water quality is needed to protect the designated beneficial use. The water quality standards regulation and EPA guidance distinguish between an "existing use" and a "designated use" (i.e., a potential use). However, water quality criteria do not reflect that distinction. The same high level of water quality is deemed necessary to protect both. That is probably not true for effluent-dependent streams. In a naturally ephemeral stream that occasionally would be dry but for flow augmentation derived from perennial effluent discharges, all existing uses have arisen under ambient water quality conditions – conditions created by the discharge of effluent. Therefore, one can conclude that existing water quality fully protects existing uses. However, it may be that better water quality would increase the richness and/or abundance of aquatic species in the effluent-dependent stream. Therefore, it is also possible to conclude that all of the potential beneficial uses are not fully supported by existing ambient discharge quality.

In an effort to ensure that existing uses achieve their full potential, permit writers typically impose effluent limitations on NPDES permits designed to ensure compliance with state or federal water quality criteria. Doing so, however, may not produce the biological improvement sought by the permit writer. This can best be understood by referring to **Figure 4-1** (note the numbers in the following text refer to the numbers on **Figure 4-1**).

Federal regulations at 40 CFR Part 122 establish minimum wastewater treatment requirements for publicly owned treatment works (POTWs). According to these regulations, all POTWs are expected to provide primary and secondary wastewater treatment (①). That level of treatment ensures adequate water quality to cause a population of aquatic organisms to arise in the effluent-dependent stream (②). However, the richness and abundance of species is not as great as it might be if water quality were even better (③). Producing better effluent quality will require advanced waste

> ***Publicly Owned Treatment Works (POTWs) [40 CFR 403.3(o)]*** – Treatment works as defined by section 212 of the Clean Water Act, which is owned by a state or municipality (as defined by section 502(4) of the Act). This definition includes any devices or systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW treatment plant. The term also means the municipality as defined in section 502(4) of the Act, which has jurisdiction over the indirect discharges to and the discharges from such a treatment works.



Economic Competition for Resources: Risk Adjusted Impact of Advanced Waste Treatment in Arid Regions.
Figure 4-1

treatment. And, depending on the facilities required, treatment costs will increase accordingly (④). Higher treatment costs increase the probability that effluent will be reclaimed and discharges diverted to beneficial reuse (⑤).

While it is often argued that water recycling increases to avoid wastewater treatment costs, actual experience indicates something quite different. There is little demand for reclaimed water that only meets secondary treatment standards. Water suppliers must overcome huge public distaste for reusing treated effluent.

The perceived value of effluent rises considerably when advanced waste treatment has been applied. Cleaner water is not only better for aquatic organisms, it is more acceptable to the general public. Nitrification to remove ammonia and filtration to reduce pathogens often reduces the public objections.

In the end, effluent is not diverted from discharge to avoid treatment costs but, rather, to recoup the cost of advanced waste treatment. Most public officials would state that they have a fiduciary responsibility to recover their capital investment in new treatment facilities and minimize the ongoing operation and maintenance costs by selling effluent rather than throwing it away. Consequently, wastewater managers are actively developing commercial markets for reclaimed water, primarily in irrigation. High quality effluent is also often used indirectly to recharge local groundwater supplies. It also can be traded to farmers and ranchers to increase the city's potable water resources. Some cities also have recycled effluent to develop non-contact urban renewal projects such as urban river walks. All such activities are considered responsible efforts to support the concept of "sustainable development" promoted by EPA.

Regardless of the specific manner in which recycled water is reused, reclamation increases the probability that the effluent flows will be diverted. And, as a result, the aquatic habitat supported by those artificial flows will be materially reduced (see ⑥ on **Figure 4-1**). Thus, where water quality was the factor precluding full attainment of the potential beneficial use, inadequate flows and insufficient habitat will severely reduce the maximum potential itself (refer to ⑦ on **Figure 4-1**). All things being equal, better water quality may improve the biological productivity and diversity of a stream. But, all things are not equal. The conclusion that the aquatic population will benefit from improved water quality is premised on the static assumption that everything else will remain the same. Analysis of the resource economics indicates that is extremely unlikely. In addition, results from this study suggest that physical and chemical factors associated with the creation of effluent-dependent waters also limit biological potential.

As the quality of reclaimed water becomes increasingly comparable to freshwater alternatives, and the free-market cost of that water offers significant value to non-potable users, a significant substitution effect begins to occur. This effect already has been observed throughout the arid West as reclaimed water is used to irrigate golf courses, parks, and street medians. In California, reclaimed water has been used to recharge local groundwater basins for many years. There also is a growing private market to buy and broker high quality effluent.

Enacted in 1972, with major amendments in 1978 and 1987, Congress enacted the **Clean Water Act** "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Furthermore, under this Act, it is the national goal of the Clean Water Act that all of our waters should be safe for fishing and swimming.

The **Endangered Species Act**, as amended in 1988, has three purposes: "...to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved...to provide a program for the conservation of such endangered species and threatened species [and]...to take such steps as may be appropriate to achieve the purposes of the treaties and conventions..." (Endangered Species Act 1988).

Congress originally passed the **Safe Drinking Water Act** in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources - rivers, lakes, reservoirs, springs, and groundwater wells.

Anectodal evidence seems to indicate that the substitution of reclaimed water intensifies when effluent undergoes tertiary treatment (nitrification and/or filtration). So, while it may not be possible to quantify the exact relationships depicted on **Figure 4-1**, it is safe to say that at this time the shape of the curves is well known.

4.3 POTENTIAL FOR WATER RESOURCE CONFLICTS

Separately the Clean Water Act, Endangered Species Act, and Safe Drinking Water Act have valuable goals, that are widely accepted and supported (see inset). However, each of these Acts was conceptualized, promulgated, and implemented separately with little regard for the potential interdependencies inherent in their requirements. However, in recent years it has become increasingly apparent that implementation of each of the Acts separately, without regard to the goals of separate, but related, Acts, is creating water resource conflicts. This conflict is most apparent in the link between implementation of the Clean Water Act and Endangered Species Act.

As described above, requirements contained in NPDES permits for the discharge of treated effluent to a surface water under the jurisdiction of the Clean Water Act are becoming increasingly more stringent, resulting in increased treatment costs. As treatment costs increase, the incentive for wastewater dischargers to sell treated effluent to recoup costs likewise increases. This cycle has important implications with regard to the link between the goals of the Clean Water Act and Endangered Species Act.

Chapter 3 of this report documents some of the ecological benefits of effluent discharged to otherwise dry riverbeds, especially as manifested in the riparian or terrestrial community associated with the watercourse downstream of the discharge. This created ecosystem has the potential to support a diverse group of species, including species designated as threatened or endangered. Moreover, it is important to note that the Endangered Species Act requires not only protection of the threatened or endangered species, but its habitat as well. As effluent creates riparian ecosystems in an otherwise dry environment, the potential for use by threatened and endangered species increases.

Independently, the Clean Water Act, through the issuance of NPDES permits with appropriate effluent limitations, and the Endangered Species Act, through its consultation process on the NPDES permit, can work for the protection of ecosystems created by treated effluent. However, because the treated effluent that creates the ecosystem is owned, it can be sold, leased, or traded, such that less effluent or even no effluent ever reaches the riverbed. The desire to divert effluent from the riverbed increases as the cost of treatment increases to meet Clean Water Act requirements. This result can and will occur regardless of the potential impact on the ecosystem created by the effluent. While the mechanisms that lead to this result are legal and appropriate given the attributes of water in the West (i.e., the rules of ownership and the value of the resource), the result can be the loss of the ecosystem created by the effluent. In an arid environment, loss of uncommon riparian ecosystems is a significant event.

Created Ecosystem in Arizona

Pintail Lake, Telephone Lake, and Redhead Marsh wetlands are effluent-dependent waters located 4 miles north of the City of Show Low, Arizona. The wetlands are created by the discharge of treated effluent from the City of Show Low wastewater treatment facility. The following is an example of the biological response to this created habitat:

> "To date ten bird species which are classified as endangered, threatened, or sensitive have been seen using the wetlands. These include the bald eagle, peregrine falcon, osprey, northern goshawk, snowy egret, belted kingfisher, American avocet, sora rail, black-crowned night heron, and the double-crested cormorant. Four of these species (the avocet, sora rail, black-crowned night heron, and cormorant) have been found nesting here. A survey done in 1991 to document total bird use on a weekly basis found 120 different species of birds using the created wetlands. Some of the birds are predators, feeding on fathead minnows, a small fish that inhabits part of this wetland system. Other animals found in the wetlands include rocky mountain elk, mule deer, pronghorn, black bear, coyote, raccoon, and various kinds of amphibians" (EPA 1993).

The use of effluent-dependent ecosystems by threatened and endangered species has been documented in the West, especially in Arizona. One of the best documented examples of the use of an effluent-dependent created ecosystem by threatened and endangered species is the Show Low wetlands in Arizona (see inset on Show Low wetlands). Other examples of the known use of these created habitats by threatened and endangered species include the Santa Cruz River, downstream of Nogales, Arizona where the Gila topminnow has been found. In 1999 the US Fish and Wildlife Service designated almost 52 miles of the Upper San Pedro and Santa Cruz Rivers, Sonoita Creek, and tributaries to the San Pedro as critical habitat for the endangered Huachuca water umbel, a semi-aquatic wetland plant. In addition to providing habitat for threatened and endangered species it should be noted that many individual states have established their own lists of sensitive species, and the use of effluent-dependent habitats by these species has been documented.

4.4 SUMMARY

Effluent-dependent waters and their associated riparian communities have significant potential to become an important habitat resource for aquatic and terrestrial species, including those species considered sensitive or listed as threatened and endangered. While it is critical that water quality be sufficient to ensure no detrimental effects on species using these habitats, it is increasingly apparent that a balance must be struck between the cost of treatment and the benefit to be achieved by incurring the cost. As water becomes an increasingly valuable commodity in the arid West, the need to establish this balance will only continue to increase.

It can be argued that the discussion of unintended consequences in this chapter is moot, and that competition for limited water resources will ultimately drive the decision to divert treated effluent from surface waters to uses such as landscaping, golf courses, and the like. However, we believe that it is important that such decisions should not be driven solely by the cost of wastewater treatment. Other factors should be considered including public values and community goals. However, for these factors to be considered it may be necessary to rethink how water quality regulatory programs are implemented in effluent-dependent waters. This issue is the focus of the next chapter.