Think Water - Reconditioning the Malden River

by

Kazuyo Oda

B. S. Architecture
Northeastern University, 1995

Submitted to the Department of Architecture in Partial Fulfillment of the Requirements for the Degree of
Master of Architecture
at the
Massachusetts Institute of Technology

February 2003

Signature of Author:
Department of Architecture
January 17, 2003

Certified by:
Wellington Reiter
Associate Professor of the Practice of Architecture

Accepted by:
Bill Hubbard Jr.
Adjunct Associate Professor of Architecture
Chairman, Department Committee for Graduate Students

Thesis Supervisor

Wellington Reiter
Associate Professor of the Practice of Architecture

Thesis Reader

Takehiko Nagakura
Associate Professor of Design and Computation

Think Water

by

Kazuyo Oda

Submitted to the Department of Architecture
on Janurary 17, 2003 in Partial Fulfillment of the
Requirements for the Degree of Master of Architecture

Abstract

The purpose of this thesis is to link water, history and culture through architectural and urban design by researching the potential for the rejuvenation of a neglected industrial site at the edge of a river. The **Malden River in Massachusetts,** one of the most polluted rivers in the Boston Harbor Watershed, was utilized by heavy industry during the late 19th and early 20th centuries for the purposes of power generation, shipping and waste removal. As the advent of modern urban systems for drainage and transport replaced the river's traditional roles, the waterfront has fallen into disuse and has become a classic post-industrial landscape. It is abandoned and contaminated, surrounded by old industrial buildings and warehouses and is more commonly known as a "brownfield."

In order to re-evaluate the relationship between water and contemporary urban culture, this thesis explores the creation of a metaphorical "source" for the river so as to establish a new and fundamental bond between the architecture and the site. The source is of critical importance due to symbolic issues of quality, origin, and renewal. The selected site, sandwiched between the towns of Medford and Everett, is chosen to **celebrate and demarcate the origin of the river,** and second to **rejuvenate the water front and surrounding industrial landscape,** which is overgrown and polluted.

These intentions are accomplished using two scales of design intervention. At one scale(the urban scale), water filtration technologies such as slow sand filtration and landscape design are brought together to create a civic space that creates a symbolic "source" for the river and celebrates its renewal. At a smaller scale, architectural interventions include a series of programs that will help develop a community awareness of the delicate relationship between culture and water. This program includes: a water research center, research library, auditorium, gallery, studio, observation tower, teahouse, restaurant and café. These programatic aspects serve to generate activity that will bring life to the site and surrounding communities.

Thesis Supervisor: Wellington Reiter
Title: Associate Professor of the Practice Architecture

Acknowledgement:

I would like to thank all of you who helped, encouraged, and supported me working on my thesis project.
Special thanks to Duke and Takehiko........also the members of the Thesis Club: Joy, David, and Noha

To Tomoko Akiba and Joe Suganuma

To Sawako Kaijima, Ryunosuke Konishi and Keon- Soo Nam, Shuji Suzumori.

To Kenneth Namkung, Britta Butler,
Charles Bodree(CAB),and Gretchen Fricke for editing my writing.

To my family: my father and mother and brother.

Contents

Project

Introduction

(1)

Water Crisis

"We'd like to believe there's an infinite supply of fresh water on the planet. But the assumption is tragically false. Available fresh water amounts to less than one half of one percent of all the water on Earth. The rest is sea water, or is frozen in the polar ice. Fresh water is renewable only by rainfall, at the rate of 40-50,000 cubic km per year. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. According to the United Nations, more than one billion people on Earth already lack access to fresh drinking water. If current trends persist, by 2025 the demand for fresh water is expected to rise by 56 percent more than is currently available..... The major bottled-water producers - Perrier, Evian, Naya, and now Coca-Cola and PepsiCo - are part of one of the " fastest growing and least regulated industries, buying up freshwater rights and dying up crucial supplies (Barrow, p.5)."

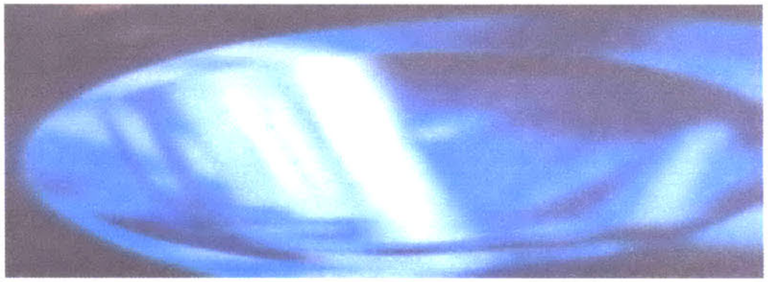
- Maude Barlow (From the Book, Blue Gold)

"The wars of the next century will be about water."

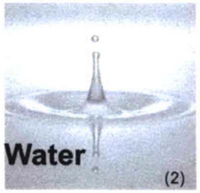
- The World Bank

Water is our most precious natural resource and it is in increasingly short supply. Inhabitants of modern urban societies, in particular, use staggering amounts of water—hundreds of gallons per day, yet show very little concern to the true gravity of the world's water situation. Many American cities were founded on water and, throughout their lives, have had access to a seemingly unlimited supply. Furthermore, modern infrastructure has created a relationship between city and water in which water is driven underground, so that it is not even seen or considered in the public mind. To us, and to many other countries of the world, water is dirt cheap and inexhaustible; seemingly, it is not precious at all. According to Michael Kravcik, a hydrological engineer, quite the opposite is true (Barrow, p.10). World urbanization not only destroys the naturalwater habitat causing a crisis in the drinking water supply for human and animals, but world urbanization also diminishes the actual amount of fresh water available on the planet. Over-built landscapes with paved roads, buildings,and other infrastructure subsequently shuttle water into drains and then out into the ocean. This deprives the inland of fresh water to naturally congregate in the wetlands and ponds where, normally, water evaporates and becomes rain (Barlow 10). In Slovakia, where Kravcik studies a hydrological cycle, fresh water disappears at the rate of approximately 250 million cubic meters (about 9 billion cubic feet) per anum due to urbanization. Since World War II, fresh water in Slovakia has already decreased about 35 percent due to this urban and industrial situation (Barrow, p.11). The urban environment often neglects to provide sufficient natural filters such as soils and sands, which help to purify water before it drains to the larger bodies of water such as rivers and oceans. Since there is no place for the water to be filtered and stored within the urban environment, impure water run-off contaminates our important water sources and endangers our lives.

Design Research



Water



"Etymology: Middle English, from Old English wæter; akin to Old High German wazzar water, Greek hydOr, Latin unda wave

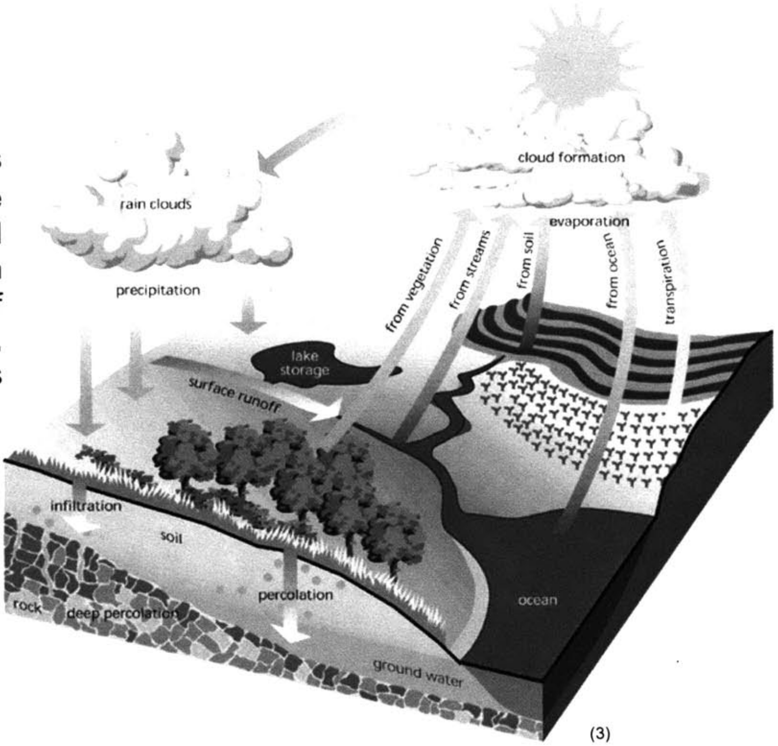
Date: before 12th century

1 a : the liquid that descends from the clouds as rain, forms streams, lakes, and seas, and is a major constituent of all living matter and that when pure is an odorless, tasteless, very slightly compressible liquid oxide of hydrogen H_2O which appears bluish in thick layers, freezes at 0° C and boils at 100° C, has a maximum density at 4° C and a high specific heat, is feebly ionized to hydrogen and hydroxyl ions, and is a poor conductor of electricity and a good solvent b : a natural mineral water — usually used in plural (1)."

Hydrologic Cycle

What is the hydrologic cycle

"The hydrologic cycle is a sequence of conditions through which water passes from vapor in the atmosphere through precipitation upon land (or water surfaces) and ultimately back into the atmosphere as a result of evaporation and transpiration — called also *hydrological cycle.* A drop of water must evaporate from a plant, earth surface, swamp, river, lake, or the sea, then fall back down to earth as precipitation (2)."



(3)

Water on Earth

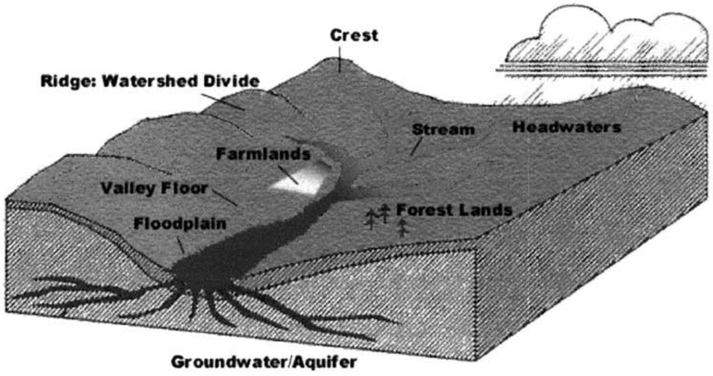
Water on Earth

"The total amount if water on earth is approximately 1.4 billion cubic kilometers (about 330 million cubic miles.) Canadian naturalist E.C. Pielou helps us visualize this statistic: if all the water on earth were solidified into a cube, each edge of the cube would be about 1.120 kilometers (about 695 miles) long, approximately twice the length of Lake Superior. The amount of fresh water on earth, however, is approximately 36 million cubic kilometers (about 8.6 million cubic miles), a mere 2.6 percent the total. Of this, only 11 million cubic kilometers (about 2.6 million cubic miles), or 0.77 percent, counts as part of the water cycle in that it circulates comparatively quickly. However, fresh water is renewable only by rainfall. Man can depend on the 34,000 cubic kilometers (about 8,000 cubic miles) of rain that annually from the "run off" that goes back to the oceans via rivers and groundwater. This is the only water considered "available" for human consumption because it can be harvested without depleting the finite water source (p5, Barlow)."

Watershead

Watershed

"A "WATERSHED" is a geographic area of land in which all surface and ground water flows downhill to a common point, such as a river, stream, pond, lake, wetland, or estuary" (Massachusetts Watershed Initiative). "Water from falling rain and melting snow generally drains into ditches, streams, wetlands, lakes, and coastal waters, or seeps into the ground. As water moves over the land it picks up sediment and dissolved materials and transports them to lakes, rivers, ponds, streams and coastal bays. Vegetation, leaf litter, fallen logs, and the naturally uneven terrain of forests and other natural areas slow down and filter runoff. Water flowing over parking lots and other developed areas speeds up and can pick up a variety of pollutants en route to water bodies"(Massachusetts Watershed Initiative). Protecting our watersheds means clean water in our streams. Clean water in our streams means healthy drinking water in our homes, safe water activities, such as swimming and boating, in our backyards, and abundant wildlife and natural resources in and around our aquatic environments. Clean water is essential for life. Threats to our clean water do not follow political boundaries, but occur within watersheds (3)."



(4)

The history of drinking water: presented by EPA-United States Environmental Protection (4)

Ancient civilizations established themselves around water sources. While the importance of ample water quantity for drinking and other purposes was apparent to our ancestors, an understanding of drinking water quality was not well known or documented. Although historical records have long mentioned aesthetic problems (an unpleasant appearance, taste or smell) with regard to drinking water, it took thousands of years for people to recognize that their senses alone were not accurate judges of water quality.


Civilization has always formed around water Supplies.(4)

Water treatment originally focused on improving the aesthetic qualities of drinking water. Methods to improve the taste and odor of drinking water were recorded as early as 4000 B.C. Ancient Sanskrit and Greek writings recommended water treatment methods such as filtering through charcoal, exposing to sunlight, boiling, and straining. Visible cloudiness (later termed turbidity) was the driving force behind the earliest water treatments, as many source waters contained particles that had an objectionable taste and appearance. To clarify water, the Egyptians reportedly used the chemical alum as early as 1500 B.C. to cause suspended particles to settle out of water. During the 1700s, filtration was established as an effective means of removing particles from water, although the degree of clarity achieved was not measurable at that time. By the early 1800s, slow sand filtration was beginning to be used regularly in Europe.

During the mid to late 1800s, scientists gained a greater understanding of the sources and effects of drinking water contaminants, especially those that were not visible to the naked eye. In 1855,epidemiologist Dr. John Snow proved that cholera was a waterborne disease by linking an outbreak of illness in London to a public well that was contaminated by sewage. In the late 1880s, Louis Pasteur demonstrated the "germ theory" of disease, which explained how microscopic organisms (microbes) could transmit disease through media like water.

During the late nineteenth and early twentieth centuries, concerns regarding drinking water quality continued to focus mostly on disease-causing microbes (pathogens) in public water supplies. Scientists discovered that turbidity was not only an aesthetic problem; particles in source water, such as fecal matter, could harbor pathogens. As a result, the design of most drinking water treatment systems built in the U.S. during the early 1900s was driven by the need to reduce turbidity, thereby removing microbial contaminants that were causing typhoid, dysentery, and cholera epidemics. To reduce turbidity, some water systems in U.S. cities (such as Philadelphia) began to use slow sand filtration.

While filtration was a fairly effective treatment method for reducing turbidity, it was disinfectants like chlorine that played the largest role in reducing the number of waterborne disease outbreaks in the early 1900s. In 1908, chlorine was used for the first time as a primary disinfectant of drinking water in Jersey City, New Jersey. The use of other disinfectants such as ozone also began in Europe around this time, but were not employed in the U.S. until


Many water treatment plants filter their water(4)

Federal regulation of drinking water quality began in 1914, when the U.S. Public Health Service set standards for the bacteriological quality of drinking water. The standards applied only to water systems, which provided drinking water to interstate carriers like ships and trains, and only applied to contaminants capable of causing contagious disease. The Public Health Service revised and expanded these standards in 1925, 1946, and 1962. The 1962 standards, regulating 28 substances, were the most comprehensive federal drinking water standards in existence before the Safe Drinking Water Act of 1974. With minor modifications, all 50 states adopted the Public Health Service standards either as regulations or as guidelines for all of the public water systems in their jurisdiction.

By the late 1960s it became apparent that the aesthetic problems, pathogens, and chemicals identified by the Public Health Service were not the only drinking water quality concerns. Industrial and agricultural advances and the creation of new man-made chemicals also had negative impacts on the environment and public health. Many of these new chemicals were finding their way into water supplies through factory discharges, street and farm field runoff, and leaking underground storage and disposal tanks. Although treatment techniques such as aeration, flocculation, and granular activated carbon adsorption (for removal of organic contaminants) existed at the time, they were either underutilized by water systems or ineffective at removing some new contaminants.

Health concerns spurred the federal government to conduct several studies on the nation's drinking water supply. One of the most telling was a water system survey conducted by the Public Health Service in 1969 which showed that only 60 percent of the systems surveyed delivered water that met all the Public Health Service standards. Over half of the treatment facilities surveyed had major deficiencies involving, disinfections, clarification, or pressure in the distribution system (the pipes that carry water from the treatment plant to buildings), or combinations of these deficiencies. Small systems, especially those with fewer than 500 customers, had the most deficiencies. A study in 1972 found 36chemicals in treated water taken from treatment plants that drew water from the Mississippi River in Louisiana. As a result of these and other studies, new legislative proposals for a federal safe drinking water law were introduced and debated in Congress in 1973.

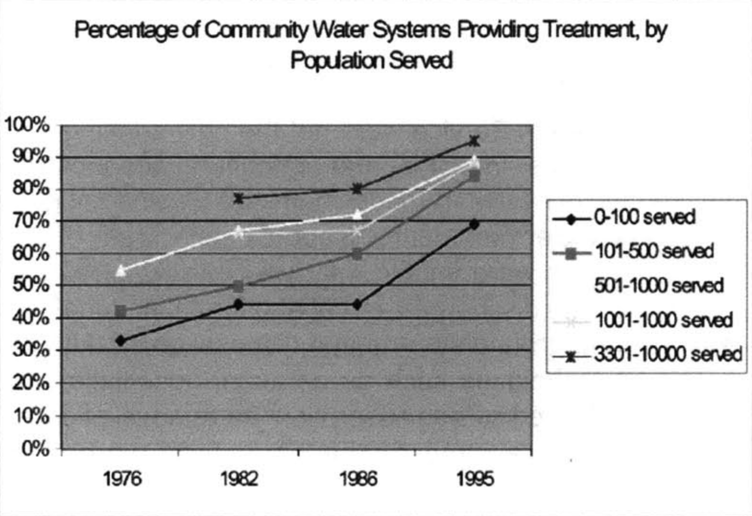


Diagram (7)

(4)

disinfection have HChemical contamination of water supplies was only one of many environmental and health issues that gained the attention of Congress and the public in the early 1970s. This increased awareness eventually led to the passage of several federal environmental and health laws, one of which was the Safe Drinking Water Act of 1974. That law, with significant amendments in 1986 and 1996, is administered today by the U.S. Environmental Protection Agency's Office of Ground Water and Drinking Water (EPA) and its partners.

Since the passage of the original Safe Drinking Water Act, the number of water systems applying some type of treatment to their water has increased. According to several EPA surveys, from 1976 to 1995, the percentage of small and medium community water systems (systems serving people year-round) that treat their water has steadily increased. For example, in 1976 only 33percent of systems serving fewer than100 people provided treatment. By 1995, that number had risen to 69 percent.

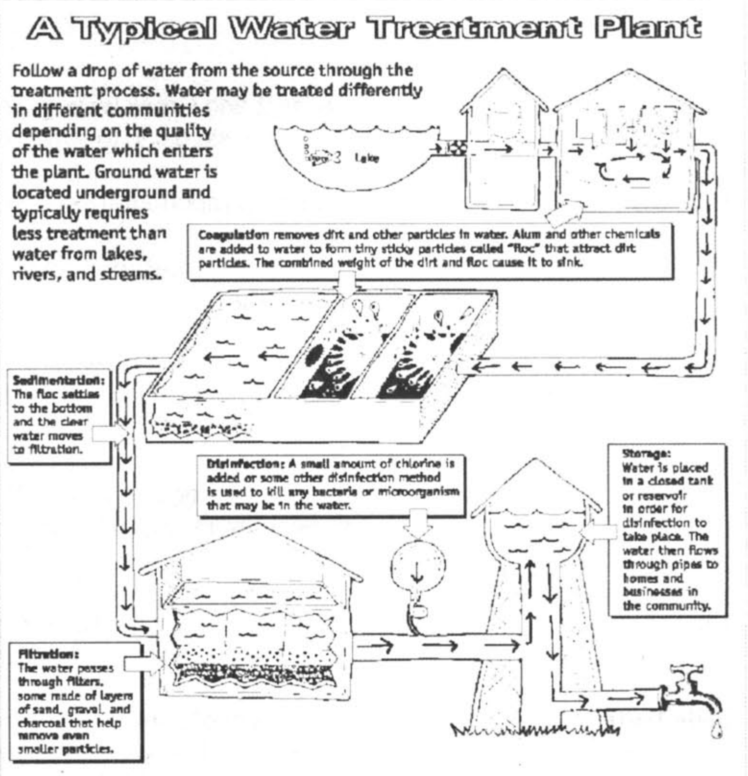
Since their establishment in the early 1900s, most large urban systems have always provided some treatment, as they draw their water from surface sources (rivers, lakes, and reservoirs) which are more susceptible to pollution. Larger systems also have the customer base to provide the funds needed to install and improve treatment equipment. Because distribution systems have extended to serve a growing population (as people have moved from concentrated urban areas to more suburban areas), additional disinfection has been required to keep water safe until it is delivered to all customers.

Today, filtration and chlorination remain effective treatment techniques for protecting U.S. water supplies from harmful microbes, although additional advances in been made over the years. In the 1970s and 1980s, improvements were made in membrane development for reverse osmosis filtration and other treatment techniques such as ozonation. Some treatment advancements have been driven by the discovery of chlorine-resistant pathogens in drinking water that can cause illnesses like hepatitis, gastroenteritis, Legionnaire's Disease, and cryptosporidiosis. Other advancements resulted from the need to remove more and more chemicals found in sources of drinking water.

According to a 1995 EPA survey, approximately 64 percent of community ground water and surface water systems disinfect their water with chlorine. Almost all of the remaining surface water systems, and some of the remaining ground water systems, use another type of disinfectant, such as ozone or chloramine. Many of the treatment techniques used today by drinking water plants include methods that have been used for hundreds and even thousands of years (see the diagram below). However, newer treatment techniques (e.g., reverse osmosis and granular activated carbon) are also being employed by some modern drinking water plants.

Recently, the Centers for Disease Control and Prevention and the National Academy of Engineering named water treatment as one of the most significant public health advancements of the 20th Century. Moreover, the number of treatment techniques, and combinations of techniques, developed is expected to increase with time as more complex contaminants are discovered and regulated. It is also expected that the number of systems employing these techniques will increase due to the recent creation of a multi-billion dollar state revolving loan fund that will help water systems, especially those serving small and disadvantaged communities, upgrade or install new treatment facilities.

(4)


A Typical Water Treatment Plant

Follow a drop of water from the source through the treatment process. Water may be treated differently in different communities depending on the quality of the water which enters the plant. Ground water is located underground and typically requires less treatment than water from lakes, rivers, and streams.

Coagulation removes dirt and other particles in water. Alum and other chemicals are added to water to form tiny sticky particles called "floc" that attract dirt particles. The combined weight of the dirt and floc cause it to sink.

Sedimentation: The floc settles to the bottom and the clear water moves to filtration.

Filtration: The water passes through filters, some made of layers of sand, gravel, and charcoal that help remove even smaller particles.

Disinfection: A small amount of chlorine is added or some other disinfection method is used to kill any bacteria or microorganism that may be in the water.

Storage: Water is placed in a closed tank or reservoir in order for disinfection to take place. The water then flows through pipes to homes and businesses in the community.

The History of Drinking Water Treatment: EPA (8)

This fact sheet is based on information (p. 16-19) from the EPA report "25 Years of the Safe Drinking Water Act: History and Trends." Please refer to the full report for details and references. You may order a copy of the report, as well as many other EPA drinking water documents, by calling the Safe Drinking Water Hotline at (800) 426-4791, or you may review the report online at http://www.epa.gov/safewater/sdwa25/sdwa.html

Office of Water (4606)
EPA-816-F-00-006
February 2000

Summary: the history of drinking water

4000 BC:	Sanskrit and Greek writings recommended water treatment filtering through Charcoal, exposing to sunlight, boiling and straining.
1500 BC:	Egyptians reportedly used the chemical alum.
1700's:	Filtration was established as an effective means of removing particles from water.
1800's:	Slow sand filtration was beginning to be used in Europe. Scientist gained great understanding of sources and effects of drinking water.
1855:	An epidemiologist, Dr. John Snow proved that Cholera was a water born disease by linking a illness in London to a public well that was contaminated by sewage.
1880's:	Louis Pasteur demonstrated the "germ theory" of disease, which explained how microscopic organic (microbes) could transmit disease through water.
Early 1900's:	The quality of drinking water becomes major focus of the public health due to diseases linking to the public water supplies.
	The design of most drinking water treatment systems built in the U.S is designed to protect the public health.
	U.S cities began to use slow sand filtration, which was almost one hundred years after Europeans used a similar method.
1908:	For the first time, Chlorine was used as a disinfectant to reduce the number of water diseases.
1914:	Federal regulation of drinking water quality began, and the U.S Public Health Service regulates the Standards for the bacteriological quality of drinking water.

Summary: the history of drinking water

1925: The U. S Public Health Service revises and expands the standards for regulatinh water quality.

1946: The U.S Public Health Service revised the drinking water quality standard.

1962: The federal standards for drinking water were significantly improved by regulating 28 substances in water and the standards were adapted by 50 states.

Late 1960's: The Public Health Service began to view the concern of water quality contaminated by industrial uses, and agricultures.

New man-made chemicals were found in the water supplies, more and more complex to purify water.

Due to the new man-made chemicals by industrial and agricultural development, treatment techniques such as aeration, flocculation, and granular activated carbon adsorption, which all removes organic contaminants no longer purifies water.

1969: The public Health Service standards only meet 60 % of the entire U.S. drinking water delivery systems.

More than half of the drinking water distribution facilities had major deficiencies, which were disinfections, clarification, or pipe and water distribution from the treatment plant to buildings.

Smaller systems, which served less than 500 customers, had the most deficiencies.

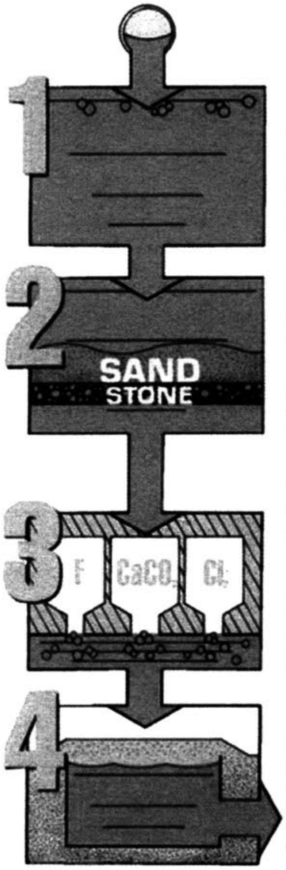
1973: The safe drinking water law was introduced.
36 chemicals found in the treated water from Mississippi River, Louisiana.

1974: The Safe Drinking Water Act, was established and has significantly improved the U.S public drinking water quality.

1976-1995 According to the survey by the EPA (Environmental Protection Agency), smaller water distribution systems also significantly improved. EPA also helps to protect public drinking water from both surface and ground water supplies. Although we have modern technology available, we still use the water purification system developed over hundreds of years ago.

Purification Processes: for drinking water

Slow Sand Filtration



Raw Water Enters the Plant

Untreated water is screened as it enters the filtration plant at the reservoir intake house. Gravity then helps the water flow through a complex piping system.

Filtration

The screened raw water is piped to 16 half-acre and six 3/4 acre filter beds. In the beds, water trickles down through 27 inches of sand and 12 inches of stone, where solid particles and microscopic bacteria are trapped and filtered out. The clear water is sent to two storage basins.

Chemicals

As the filtered water travels to storage, three chemicals are added:

Flouride - to help prevent tooth decay

Lime - to reduce the water's natural acidity which, in turn, protects pipes from corrosion

Chlorine - to kill any remaining bacteria

Storage

Up to 15 million gallons of water can be stored in the plant's two underground storage basins. These concrete basins are continuously replenished as we use the filtered water.

CLEANING THE FILTERS - Slow Sand Filtration

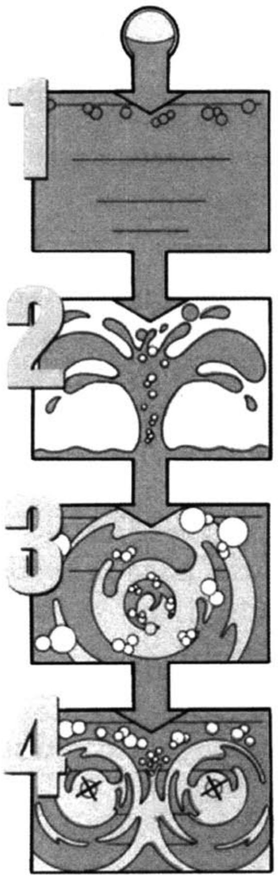
"Each filter bed is cleaned every two to eight weeks. With all but a foot of water drained, a tractor pulls a spring tooth harrow through the top 12" of sand. Like a large rake, the harrow loosens trapped particles, which are then washed into a nearby drain. Cleaning is completed the following day using a dry harrowing process. Each bed must be reconditioned about every 12 years. All the sand is shoveled out - by hand - and cleaned with specially designed hydraulic equipment (5)."

CLEANING THE FILTERS - Rapid Sand Filtration

"Each filter bed is backwashed once a day to remove contaminants trapped in the sand. Water - from a 500,000 gallon tank high above the plant - is forced through the bottom of the filter, stirring the sand and washing away the contaminated particles. Each filter takes only 15 minutes to clean (5)."

Purification Processes: for drinking water

Rapid Sand Filtration



Raw Water Enters the Plant

Water from Barkhamsted and Nepaug flows through a 7-foot tunnel in Talcott Mountain to Reservoir No. 6. From the reservoirs it enters the plant's intake house, where it travels by gravity through a large concrete pipe to the aerator.

Aeration

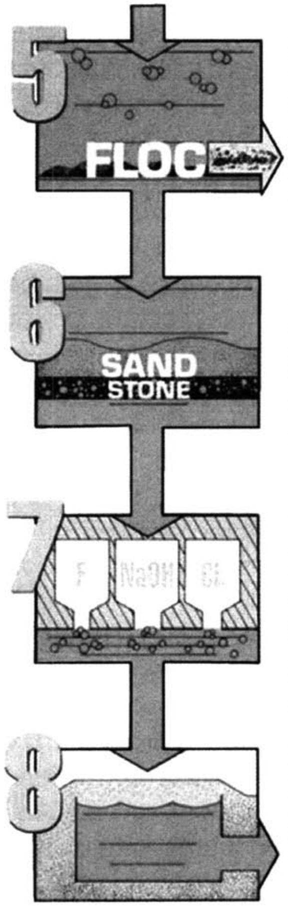
The aerator's turbulent, bubbling action releases concentrated gasses in the water, improving its taste. Aluminum sulfate, which helps remove suspended particles, is also added here.

Flash Mixing

Aerated water then flows to the flash mixing tank, where the aluminum sulfate is thoroughly blended.

Flocculation

Chemical mixing continues in the flocculation chamber, where the aluminum sulfate causes the small, suspended particles to stick together and sink to the bottom of the chamber. These particles are called floc.



Sedimentation

The water gradually moves to the neighboring sedimentation basin, where the floc is automatically removed. The floc is sent to another part of the plant for treatment, while the remaining water goes to the sand filters.

Filtration

The remaining particles are removed in the six filter beds. Each 1,260 square-foot bed holds 60,000 gallons of water. Water slowly enters the beds and gradually passes through 30 inches of sand and 12 inches of stone, where any remaining impurities are removed.

Chemicals

As the filtered water travels to storage, three chemicals are added:

Flouride - to help prevent tooth decay

Sodium Hydroxide - to reduce the water's natural acidity, which, in turn protects pipes from corrosion

Chlorine - to kill any remaining bacteria

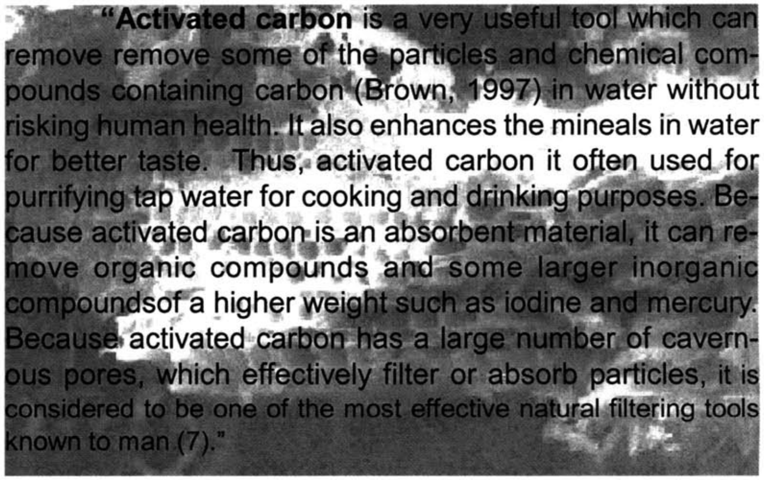
Storage

Up to 10 million gallons of filtered water are stored in two underground concrete filtered water basins that are continuously replenished as the water is used.

New Technology for Water Treatment

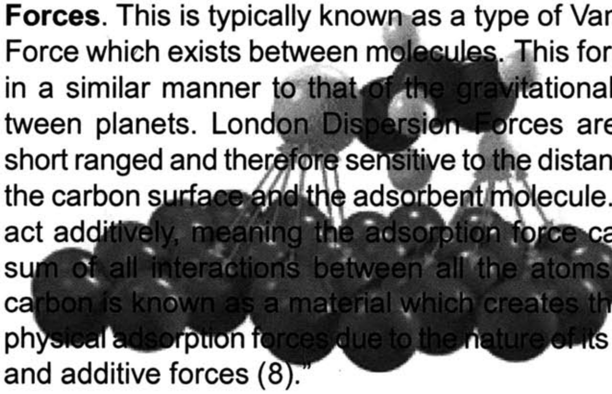
"**Ultraviolet technology** has been developed recently has become more of a popular alternative to the use of chemicals. According to the Chief Scientist of Trojan Technologies Inc., William L. Cairns, UV light only affects molecules that absorb UV, except a large number of microbial molecules such as the sugar-based extracelluar polymers which, when degraded by chemical disinfectants, can become good nutrients for microbial growth. Chlorine was used first in 1908 for the first time as a disinfectant to reduce the cases of water related diseases. Since then, its use in this manor has been viewed as a controversial issue to many people despite the minimal chlorine content in the water which is in small amounts and considered acceptible to the human body. Cairns argues that the use of ultraviolet technology is a very effective disinfectant against numbers of bacteria and viruses including Bacillus anthracis, Clostridium tetani, Corynebacterium diphtheria, Escherichia coli, Legionella pneumophila and many others. Through the application aof a UV dose of 20 milli-watt-seconds per square centimeter, over 99.9 percentage of bacteria and viruses in water can be eliminated. More over, UV water treatment has been successfully utilized for disinfecting a wide range of water and waste water qualities such as surface water and ground waters, industrial products and process waters, and municipal wastewaters. Another benefit of selecting UV disinfection would be that it has a minimum health risk due to the minimal formation of by- products and due to the fact that there are no toxic chemicals involved or that need to be transported, stored or handled (6)."

Organic Water Treatment



"**Activated carbon** is a very useful tool which can remove remove some of the particles and chemical compounds containing carbon (Brown, 1997) in water without risking human health. It also enhances the mineals in water for better taste. Thus, activated carbon it often used for purrifying tap water for cooking and drinking purposes. Because activated carbon is an absorbent material, it can remove organic compounds and some larger inorganic compoundsof a higher weight such as iodine and mercury. Because activated carbon has a large number of cavernous pores, which effectively filter or absorb particles, it is considered to be one of the most effective natural filtering tools known to man (7)."

(10)

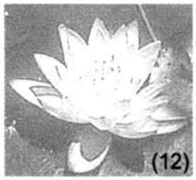


"Adsorption and London Dispersion Forces

Adsorption is created by London Dispersion Forces. This is typically known as a type of Van der Waals Force which exists between molecules. This force behaves in a similar manner to that of the gravitational forces between planets. London Dispersion Forces are extremely short ranged and therefore sensitive to the distance between the carbon surface and the adsorbent molecule. The forces act additively, meaning the adsorption force can work the sum of all interactions between all the atoms. Activated carbon is known as a material which creates the strongest physical adsorption forces due to the nature of its short range and additive forces (8)."

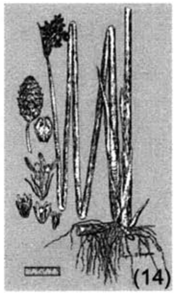
(11)

Water Treatment by Wetlands Plants

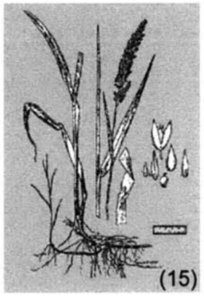


"According to Louise Kulzer, of the Office of Water Quality for the Municipality of Metro politan Seattle (METRO), wetland plants help to puriffy water. Some of the wetland plants such as water parsley, hardback, sedges, duckweeds, waterlilies, bulrushes, and cattails are known to separte metals from the water. Cattails provide a wildlife habitat while removing such metals as nitrate, lead, cadmium, cobalt, and zinc from water. Rushes and bulrushes also help break down organic pollutants in the water (9)."

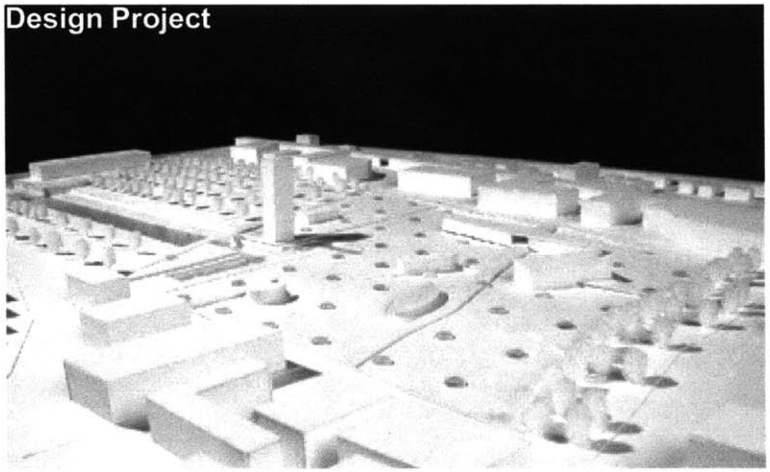
While Cattails (Typha latfolia L.) provides wildlife habitat, it removs nitrate, lead, cadmium, cobalt, and zinc from water. (10)



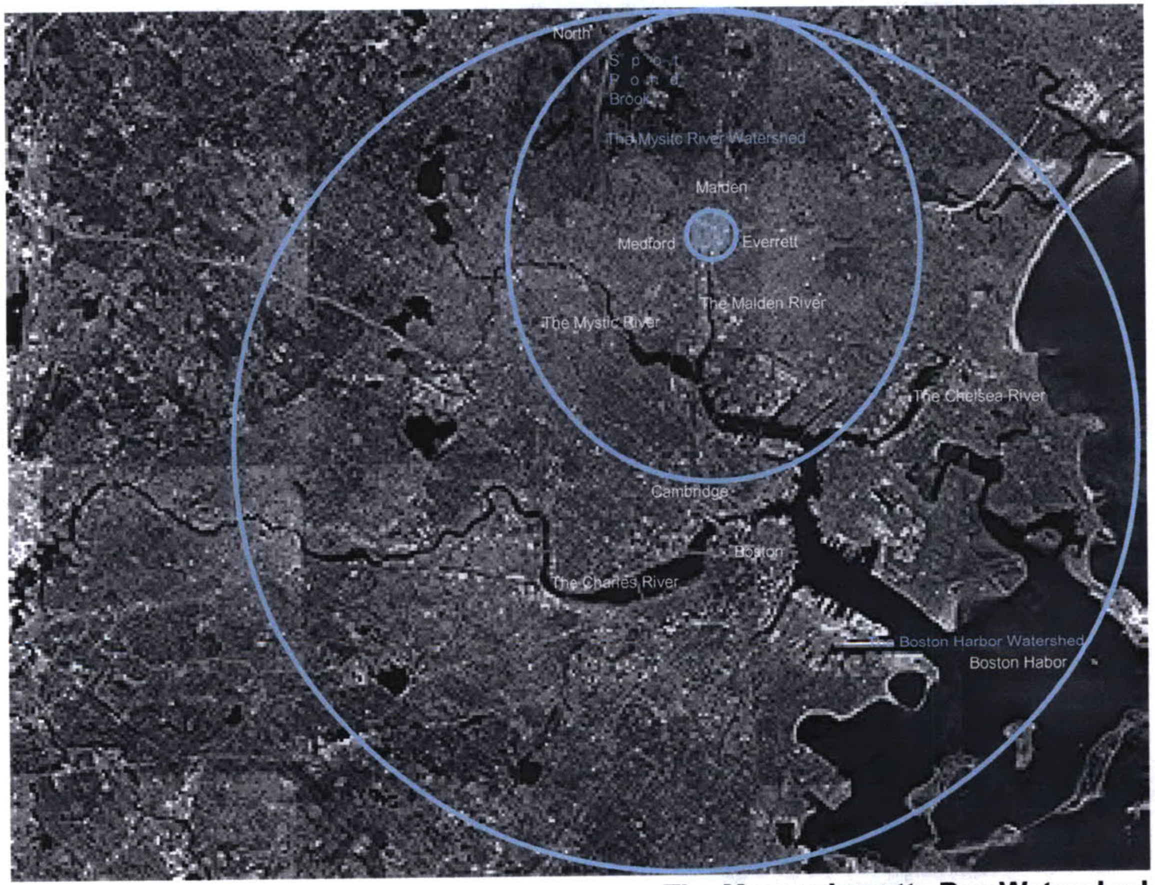
Bulrushes removes bacteria, oil, organics, and nutrients. The rushes (not pictured) can also remove heavy metals such as cobalt, copper,nickel, manganese, and zinc. (11)



Reed canarygrass can remov mercury. (12)


Design Project

Site Analysis



The Massachusetts Bay Watershed (16)

The Malden River is a part of large watershed area, called **"The Mystic River Watershed** (13)**,** located 3 miles north of the Boston and Cambridge area. The Malden River begins from **Spot Pond Brook,** and has three small tributaries; however, the river actually appears at the Northern tip of river and ends at the Amelia Earhart Dam.From this watershed, water will eventually travel to the **Massachusetts Bay Watershed** (13)**.**

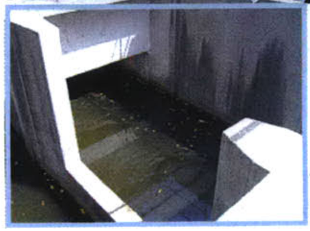
The head of the Malden River is located between the **Medford** and **Everett** communities just outside of Boston, Massachusetts. This natural drainage basin is situated between Charles Street, Medford Street, Canal Street, and Commercial Street and lies next to a railcar corridor.

The primarily river source is fed by storm water and runoff, and has many problems along the **shore line including erosion, trash, deteriorating walls and dilapidated docks and piers** (14)**.**

The Malden River head- water is considered a watershed, which is often affected by non-point source pollution (nps). In this area, water and pollutants enter the river in the form of storm water runoff from surrounding land and streets. Because of this process of natural water purification, the origin or head- water of the water source is extremely important. The purity of drinking water is dependant upon the naturally occuring water purification process. This process occurrs whenever water flows towards a natural watershed basin (13).

Site Analysis

(16)



The image to the left is the existing condition of the northen tip of the river - the origin of the Malden River

(16)

Site History

The Malden River looking South

The View of Canal Street

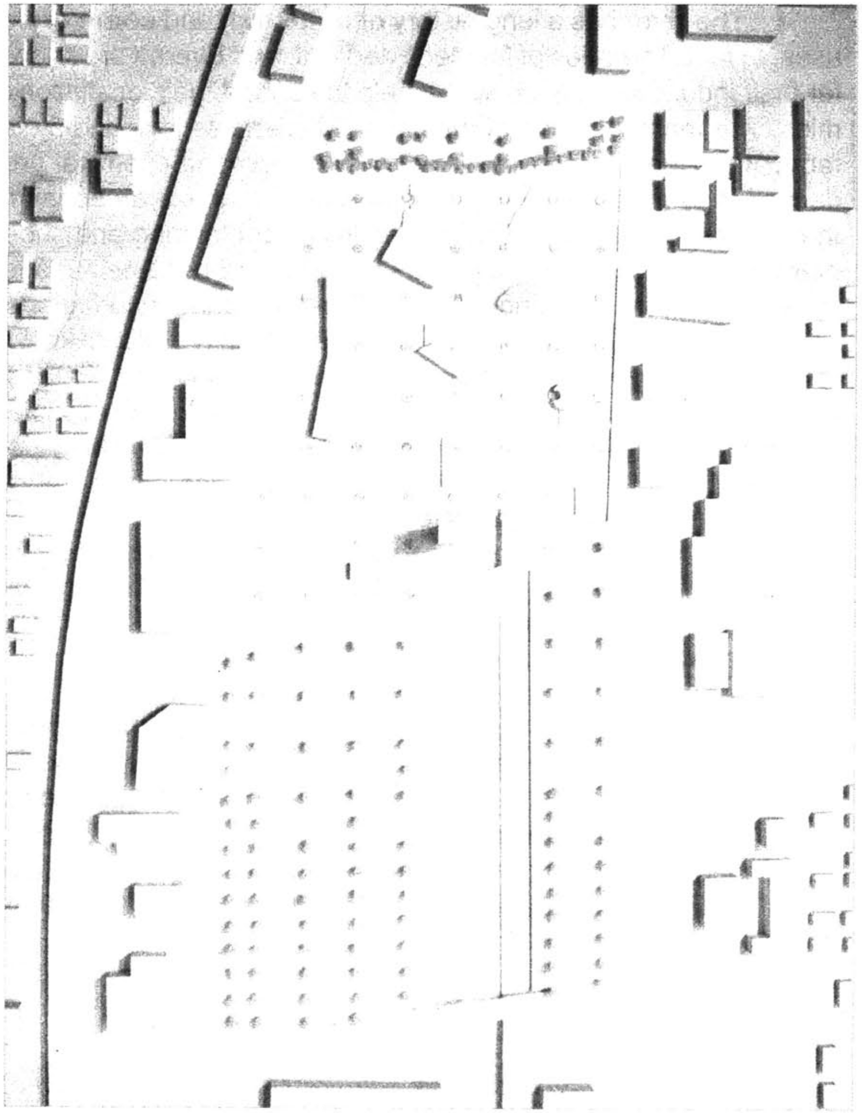
The river has a long history of **industrial** and **commercial** uses. In fact, The cities of Malden, Medford, and Everett are known for their industrial products which help to support their local economies. The manufacturing of the city of Malden has included metal fabrication, food processing, electronic equipment, chemical production, and machine parts. Industrialization in this area began in the 19th century, when it became an important tanning and shoe-manufacturing center. During that time, Medford became a leader in the Clipper Ship building industry as well as manufacturing brick and tile. Everett was a blue-color working community and also known for the various type of industries, manufacturing and trading. In the mid-ninteenth century, the large area of the river side was occupied by the General Electric Company and the river became very polluted. In 1966, when the Amelia Earhart Dam was created, it restricted commercial shipping into the river.

The northern tip of the river today remains as a post industrial landscape which is neglected and abandend by having been occupied by many enormous warehouses and factories. Since the river site was heavily utilized by these industries, it became a "brownfield" (15).

"A **brownfield** site is any land or premises which has previously been used or developed and is not currently fully in use, although it may be partially occupied or utilised. It may also be vacant, derelict or contaminated. Therefore a brownfield site is not necessarily available for immediate use without intervention (Journal of Environmental Planning and Management, V43(1). p49-69. Jan 2000.)"

(16)

Design



This thesis is concerned with investigating and re-establishing a relationship between water and contemporary culture in the society today. In an effort to address the issue of water, especially in an urban environment, an architectural intervention was to mediate the natural water generating cycle of a river and the surrounding context. In order to form a philosophical and physical link between the issues of water and our contemporary culture, a site for the architectural intervention had to be established. On a local level, (which could also be seen as a prototypical one), the **Malden River exists as a prime candidate for this exploration due to its pre-existing conditions of shoreline erosion, deteriorating walls, trash, and dilapidated docks and piers** as discussed earlier. These traits make such an intervention a very powerful and appropriate one in a context where neglect and abuse of natural resources exists. Thus, a **prototypical manifestation** is also an appropriate response based on the fact that **this site typology exists universally in our world today.**

The **Northern-most end of the Malden River** is designed to **celebrate and mark the origin of the river** as well as **rejuvenate the waterfront and the post-industrial landscape,** which has been neglected and contaminated. By activating this site with the notion of water and a new architectural intervention, the attempt was to **re-connect the two communities of Medford and Everret,** that were separated by the river. Thus, the two major streets in this artifical pond are designed as a bridge to connect the two community of the towns.

Programing

This thesis proposes a number of architectural interventions all at three different types of scales: ***infrastructure, landscape*** and ***architecture*** to create **a new civic space** with a purified water of the **water terrace** for the neighborhood community.

The first intervention is Infrastructure, which proposes **a water terrace with multiple-miniature water purification plants utlizing Slow Sand Filtration** and **a catch basin,** (a temporary water storage for purifed water which also picks up trush and organics from the water before sending it back to the origin). **Slow Sand Purification is used to purify both the origin of the water from the Spot Pond Brook and storm/ runoff water, which is the major water source of the Malden River. This would help to purify the contaminated water of the river and would bring people of the community to the waterfront. The purified water will be stored in the Northern most part of the site in the "water terrace."**

Another intervention was the design of the ***landscape*** along the river with **green space** and tree plantings to create **a buffer zone** for the river, which **protects the water source form the direct urban runoff water.** This also helps to **maintain the shoreline from its natural errosion and create a natural habitat for wildlife.**

Last, there are a number of ***architectural elements*** **in the project** including a **water research center, research library, auditorium, gallery, studio, observation tower, teahouse, restaurant** and **café.** Each program of the buildings has a critical importance in the role of establishing a didactic relationship between one another and the water. For instance, the water research center serves communities and visitors to provide information regarding local water as the Malden River. Another example is the research library, the surface of the reading tables and surface of the water are co-planar. So as one notices the condition they will become more aware of the relationship between water and our culture. The aduitorium serves a similar purpose by setting the audience next to water; however, it also creates the relationship between the origin of the water to the auditrium - meaning the audience can see the origin of the Malden River while they are sitting in the auditrium. In addition,a teahouse was designed in order to explore the notion of new technology in the purification porcess - see page 24 for **Ultraviolet technology.** The water could be purified to a drinkable quality if it used multi-layers of water purification treatment with ultraviolet technology for the treatment process.

The new civic space is accompanied with these architectural interventions and will serve to generate activity that will bring life to the site and surrounding community. The artifical water pond with multi- miniture water purification plant attracts people, especially during the summer since they can walk in the pond with bear feet to experince the importance of water.

Summary for the programs:

Infrastructure

the origin of the Malden River
multi-miniture water purrification plants(slow sand filterlation)
a catch baisn
bridges to re-connect the city of Medford and Everett

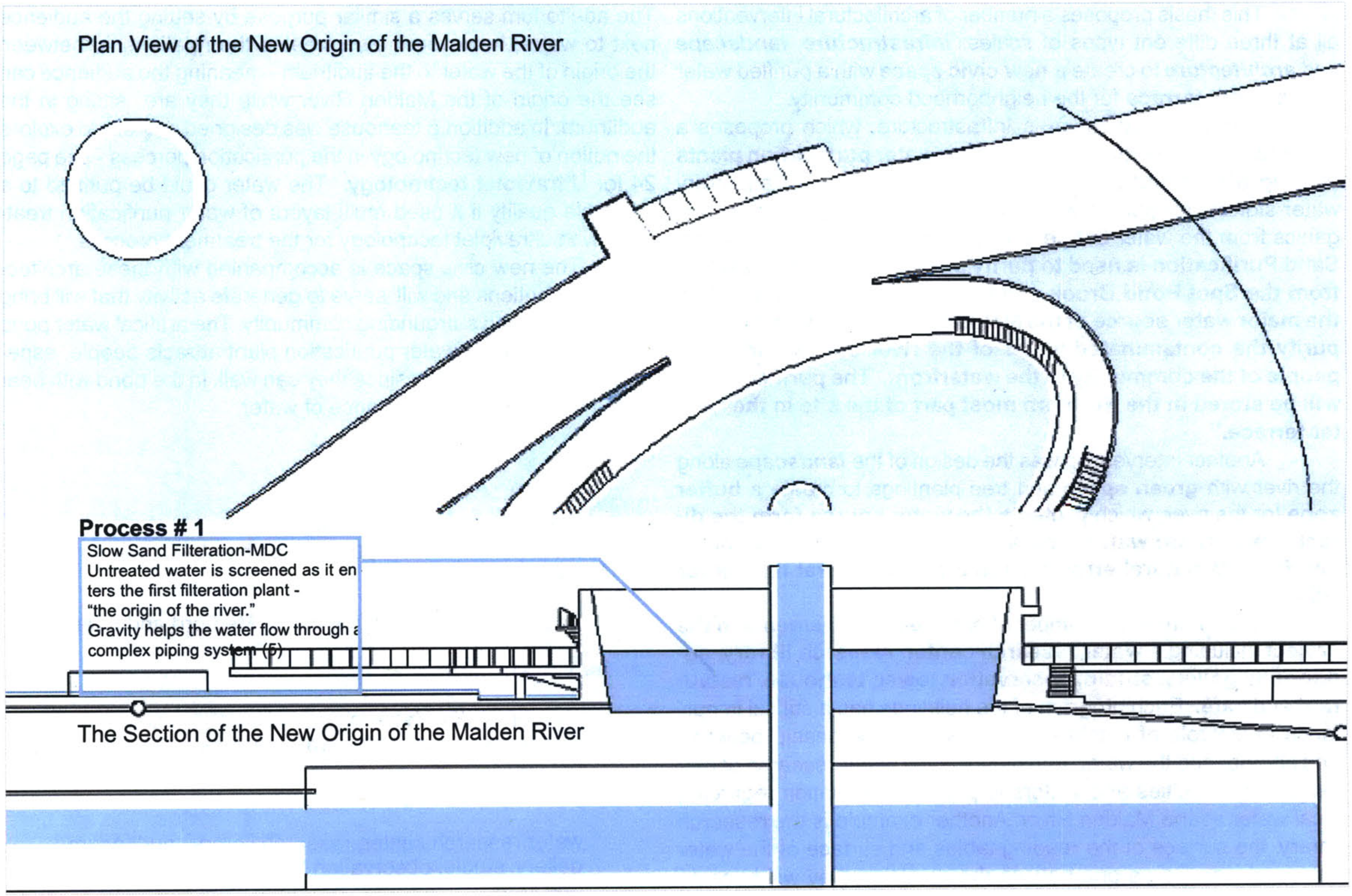
Landscape and Urban design

a green park with trees
Large civic space with a water terrace
parking spaces

Architecture

water research center, research library, auditorium, gallery, studio, observation tower, teahouse, restaurant and café.

The New Origin of the Malden River



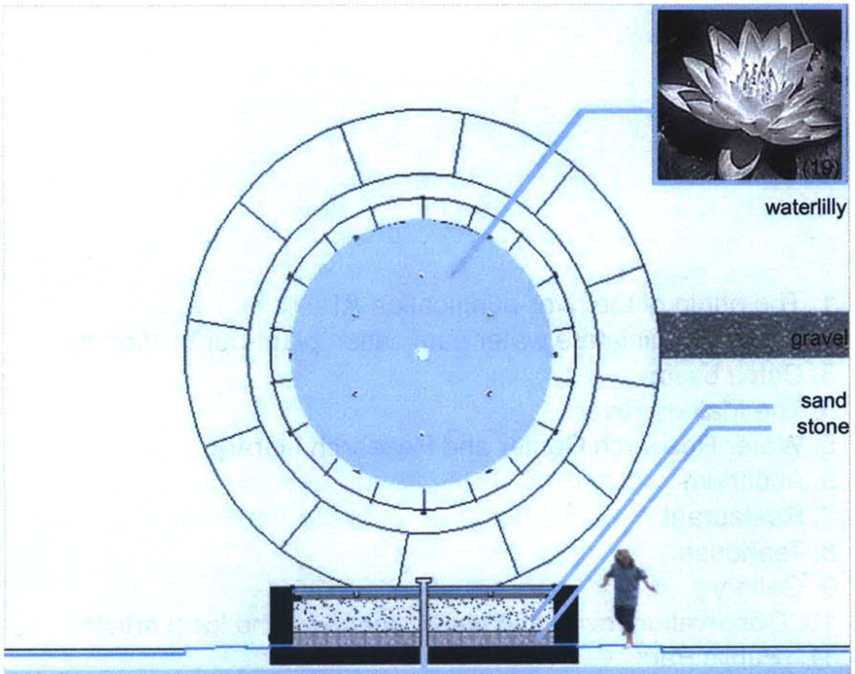
Plan View of the New Origin of the Malden River

Process # 1

Slow Sand Filteration-MDC
Untreated water is screened as it en
ters the first filteration plant -
"the origin of the river."
Gravity helps the water flow through
complex piping system (5)

The Section of the New Origin of the Malden River

Miniature-Water Purification Plant



Plan and Section of
Miniature-Water Purification Plant

Slow Sand Filterlation (refer to the page 22)

Process # 2

The screened water is piped into the 20 feet diameter of the small filter bed with an area of 314 sq. ft. In this bed, water will be adsorbed by 27 inches of sand and 12 inches of stone, where the organic particles and microscopic bacteria are trapped and filtered through. The clear water is then poured into the water terrace at the Northern end of the Malden River.

Design Criteria

The number of purification plants required at the site was an assumption based on the information regarding Slow Sand Filteration of The West Hartford Water Treatment Facility in Connecticut. This information was provided by the Metolopolitan District Council -The MDC.

West Hartford Water Facility can porcess approximately 50 million galons per day with 16 x 1/2 acre and 6x 3/4 acre filter beds.
This indicates that the area requires for the filtering bed will be approximately $544500ft^2$.

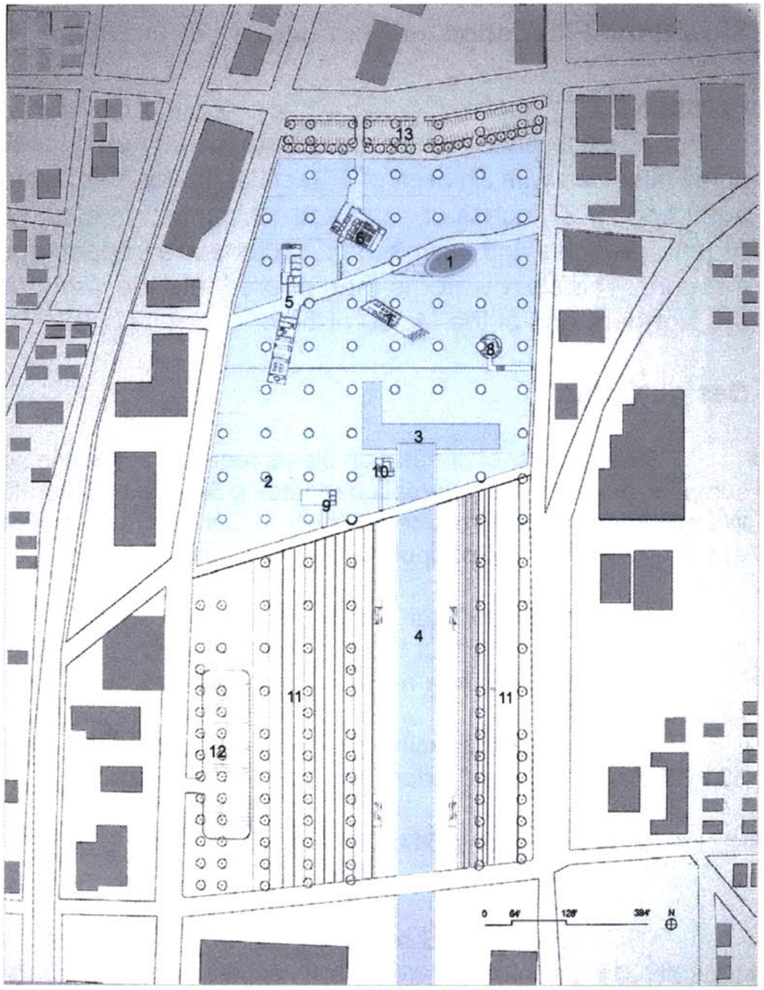
Assume that multi miniture water purification plants can prcess 1/50 th of the that of west Harford Water Treatment Facility.

$$50 \text{ million galons}: 544500 \text{ ft}^2 = 1 \text{ milion galon} : X$$
$$50X = 544500 \text{ ft}^2$$

The reqired filterlation bed area will be 10890 ft^2 total.
$10890\text{ft}^2 / 314 \text{ ft}^2 =$ minimum of 35 units of the purification plants required. When water is minimum amount available, which is 1 million gallon at the site, the depth of water will be aproximetally 3 inches. This depth can be changed by controlling the individual plant.

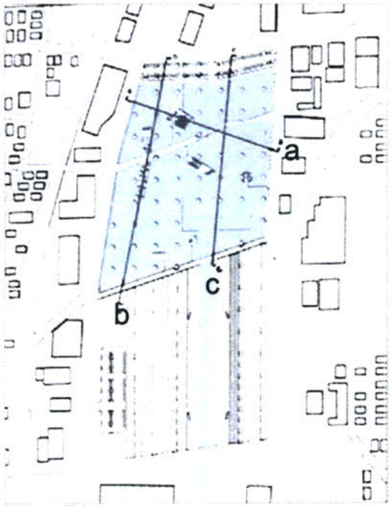
The number of the purification plants in the actual design are provided about 50 units. (5)

The Malden River Site Master Plan



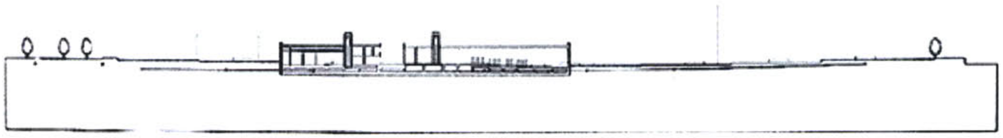
1. The origin of the river-puriffication #1
2. The multi-miniature water purification plant-purffication #2
3. Catch basin
4. The Malden River
5. Water Research Center and Research Library
6. Auditrium
7. Restaurant
8. Teahouse
9. Gallery
10. Observation tower and studio space for the local artists
11. Public Park
12. Paking
13. Parking

Site Section



Key Plan

Section a

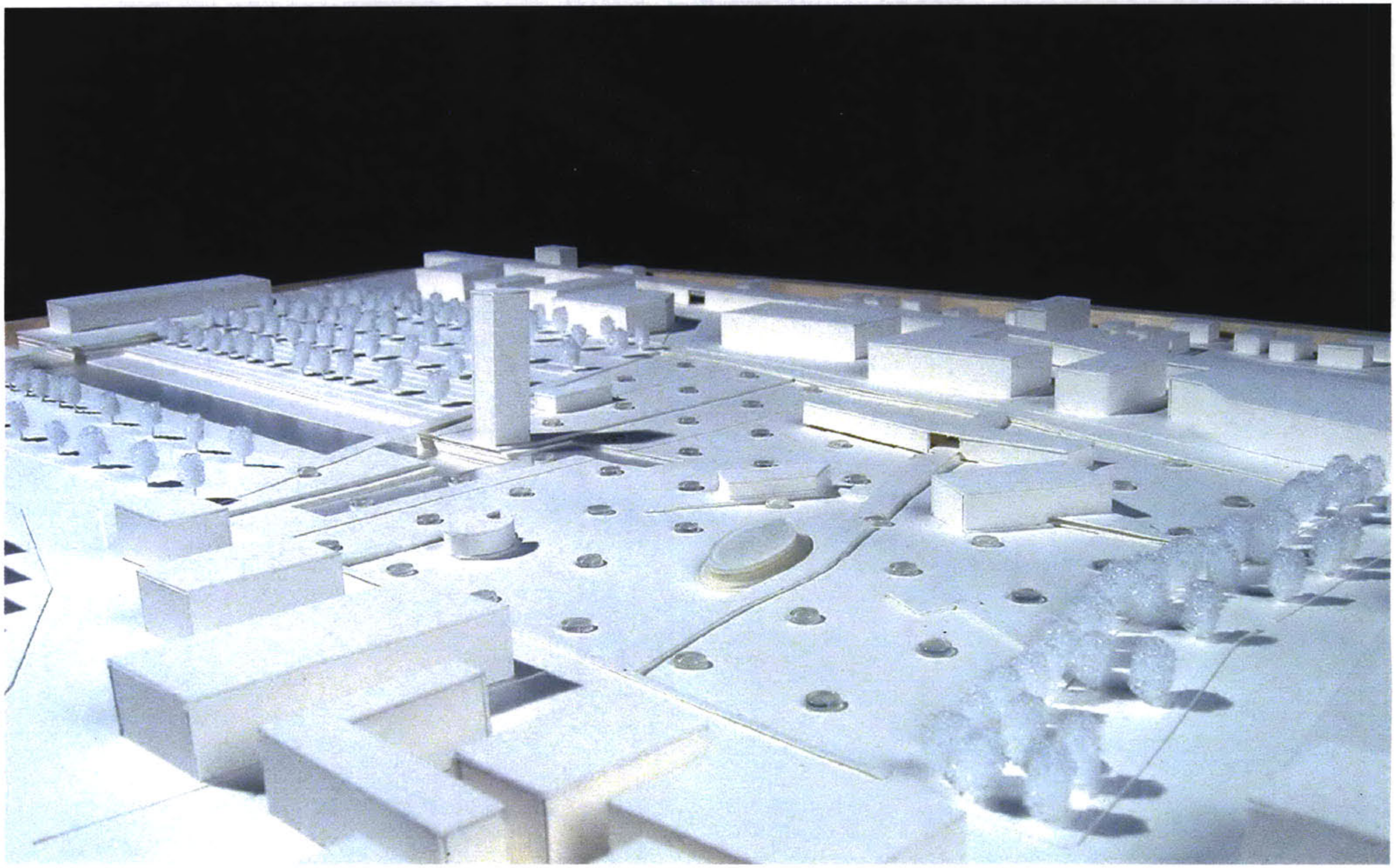


Section b

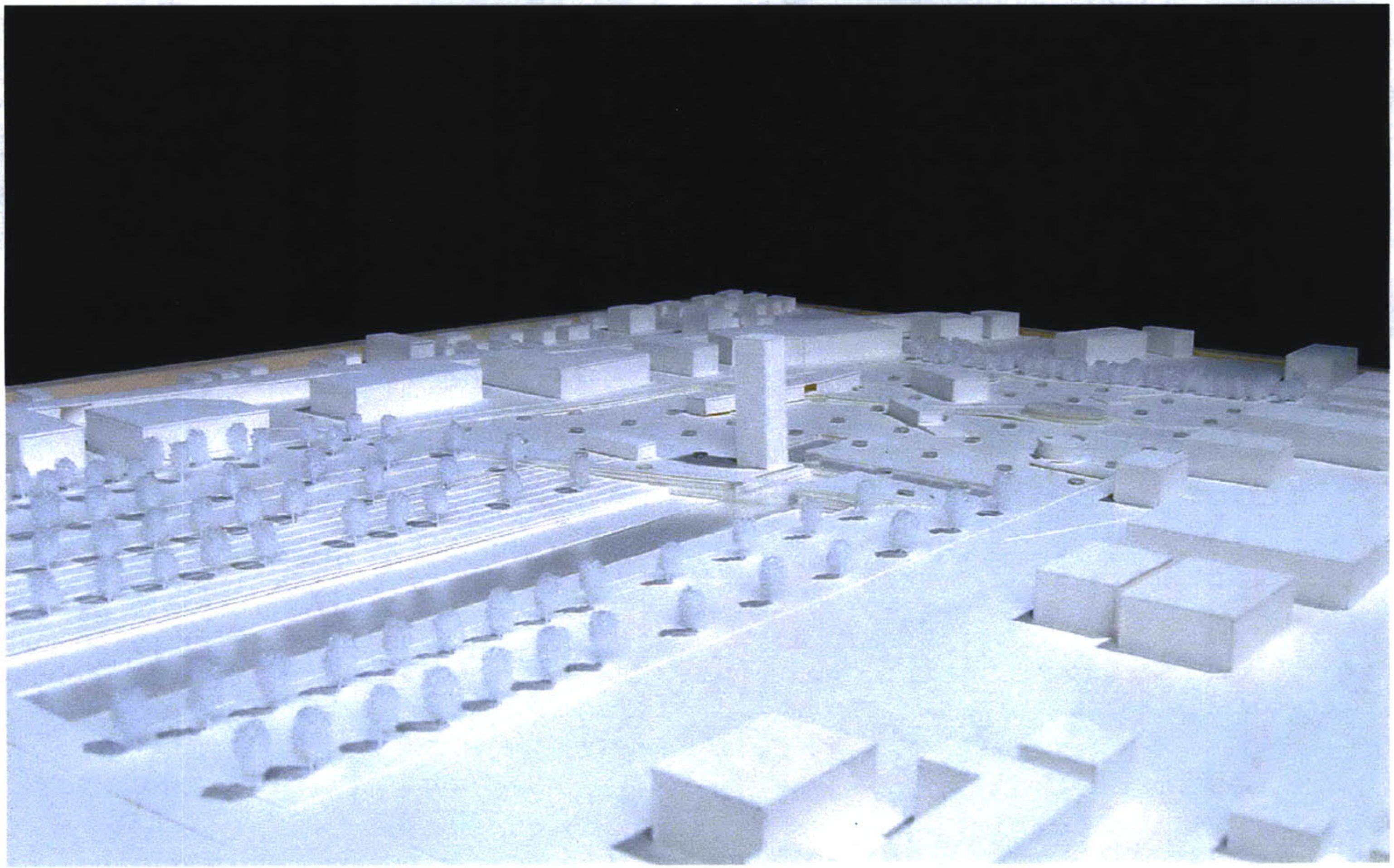
Section c


Urban Design

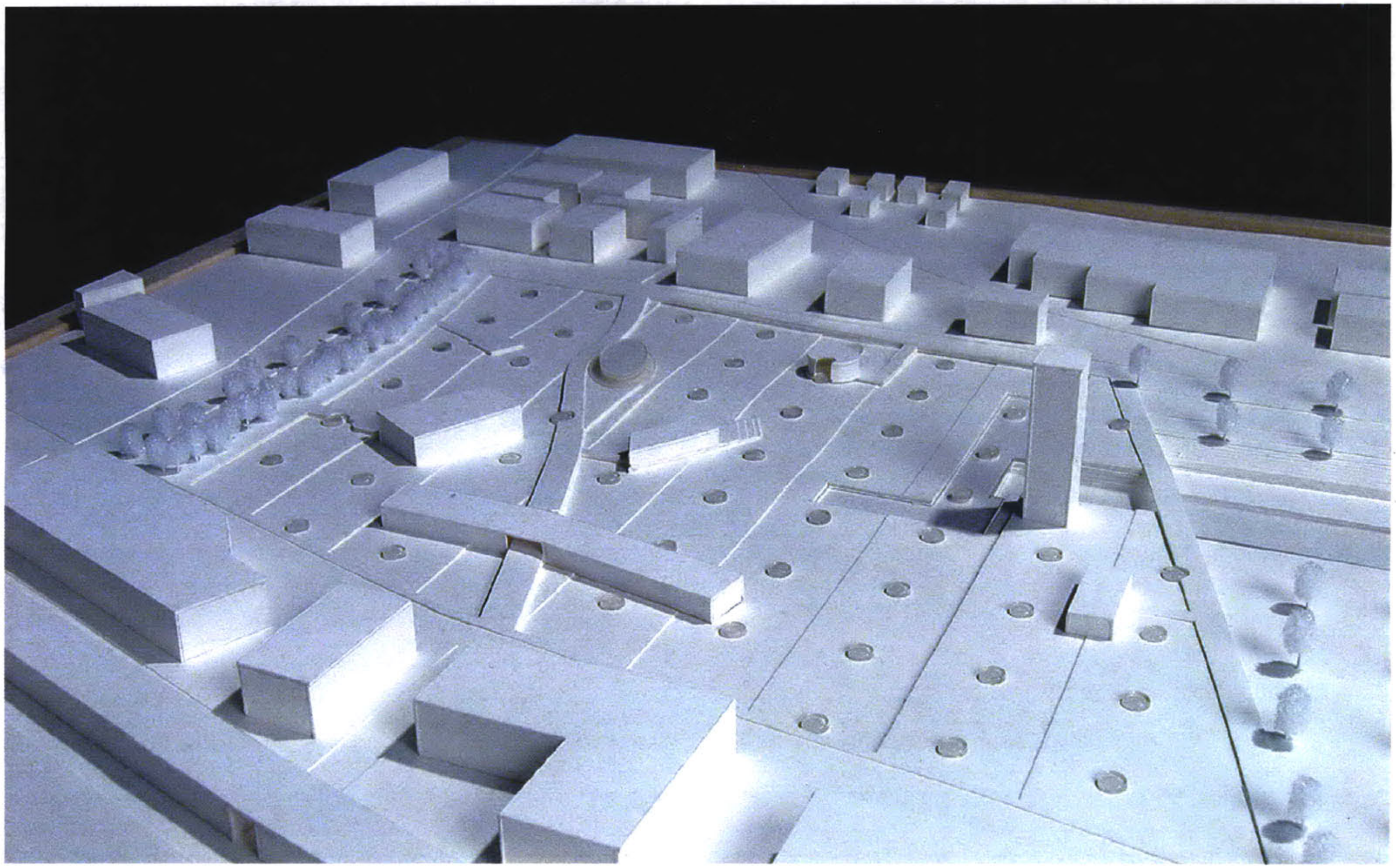
Urban Design



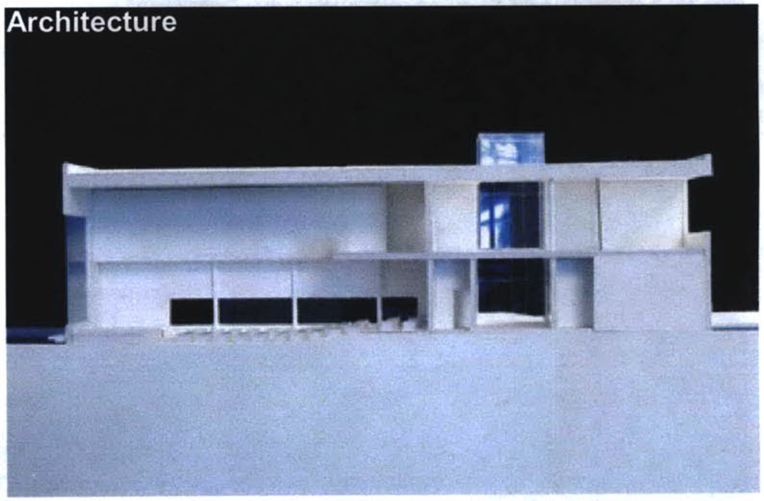
Urban Design



Urban Design

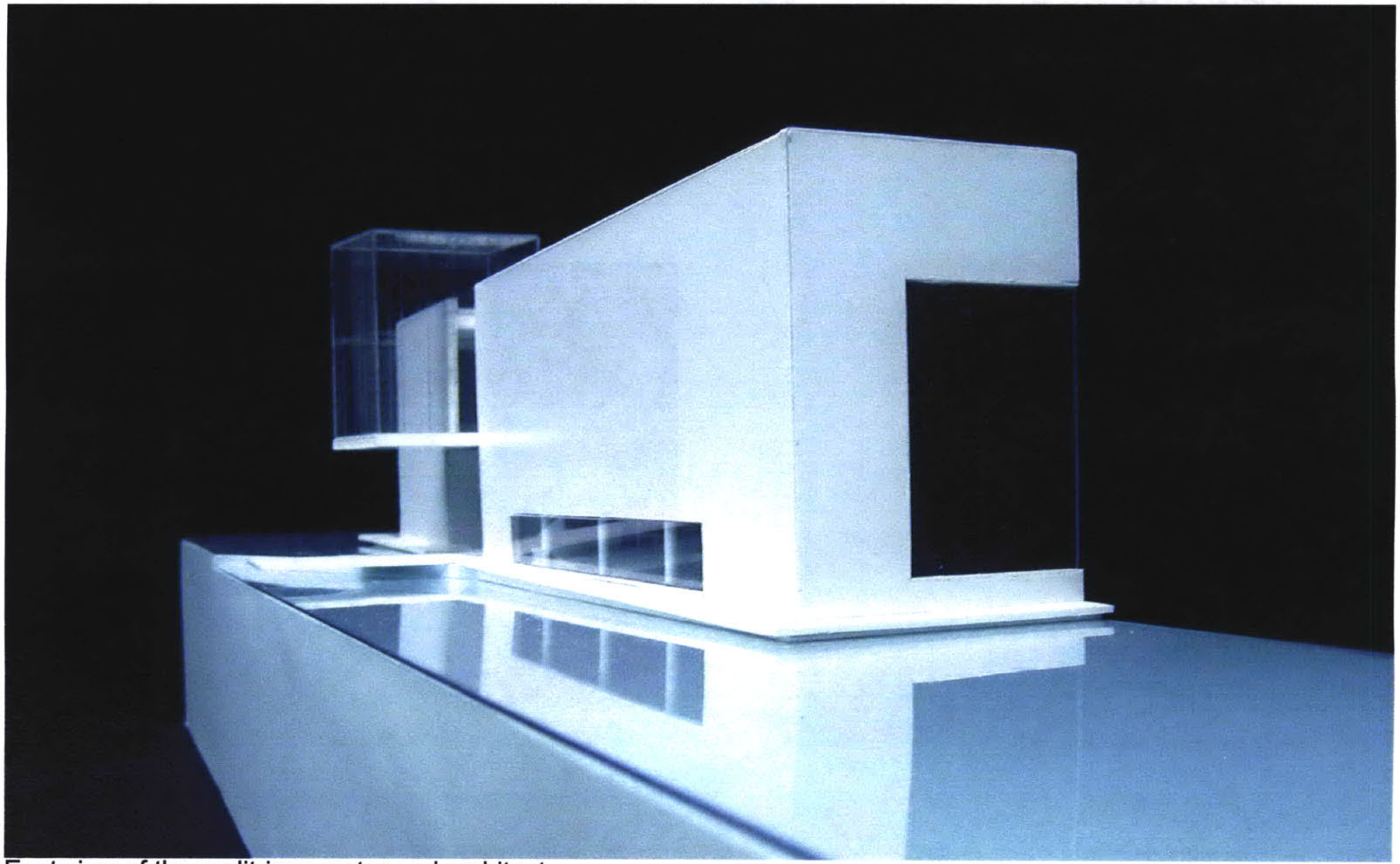


Urban Design

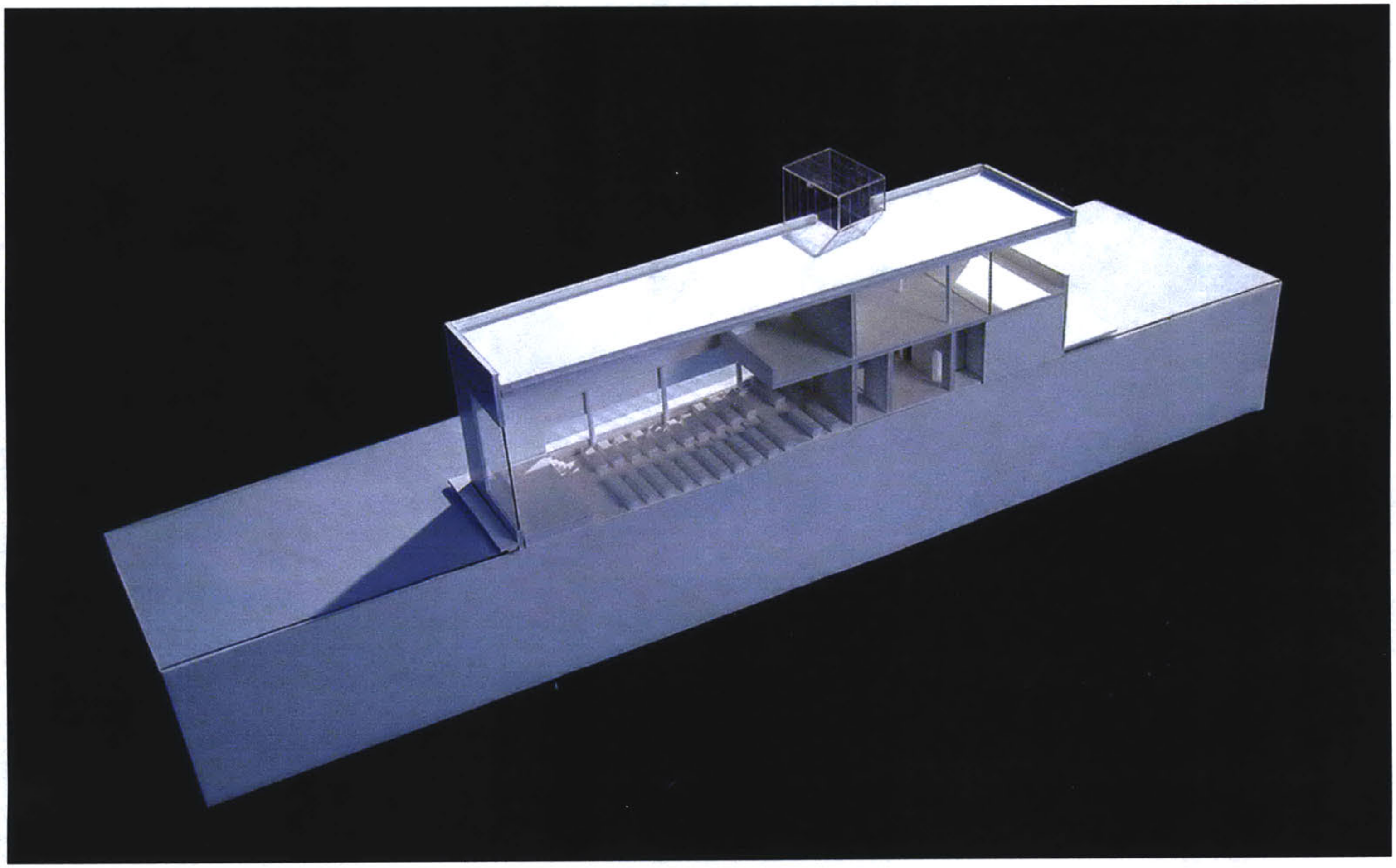


Architecture

Architecture

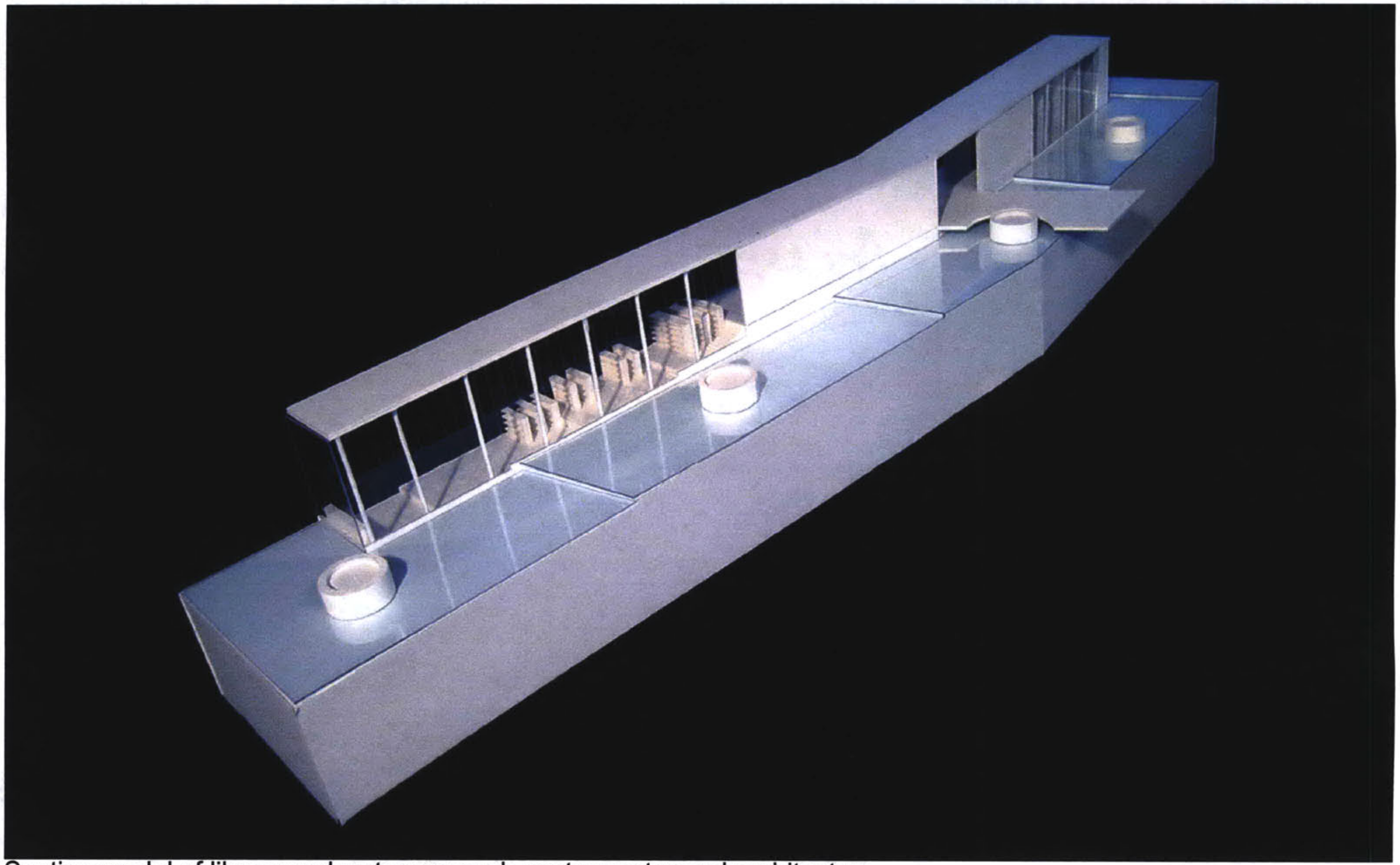


East view of the auditrium: water and architecture
The audience can view surrounding water while they are seated at the auditrium.



Section model of the auditrium: The interior view

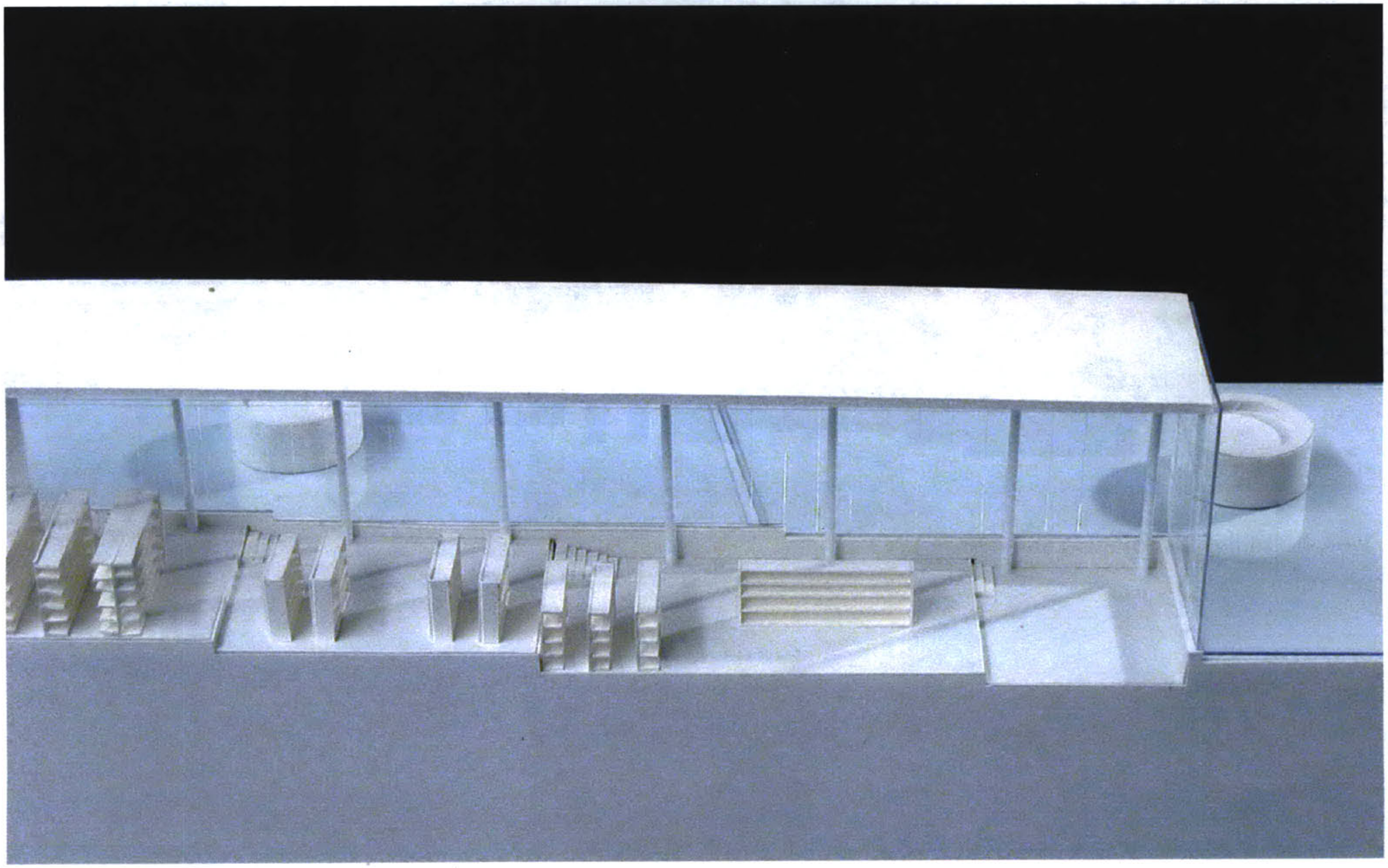
Architecture



Section model of library and water research center: water and architecture

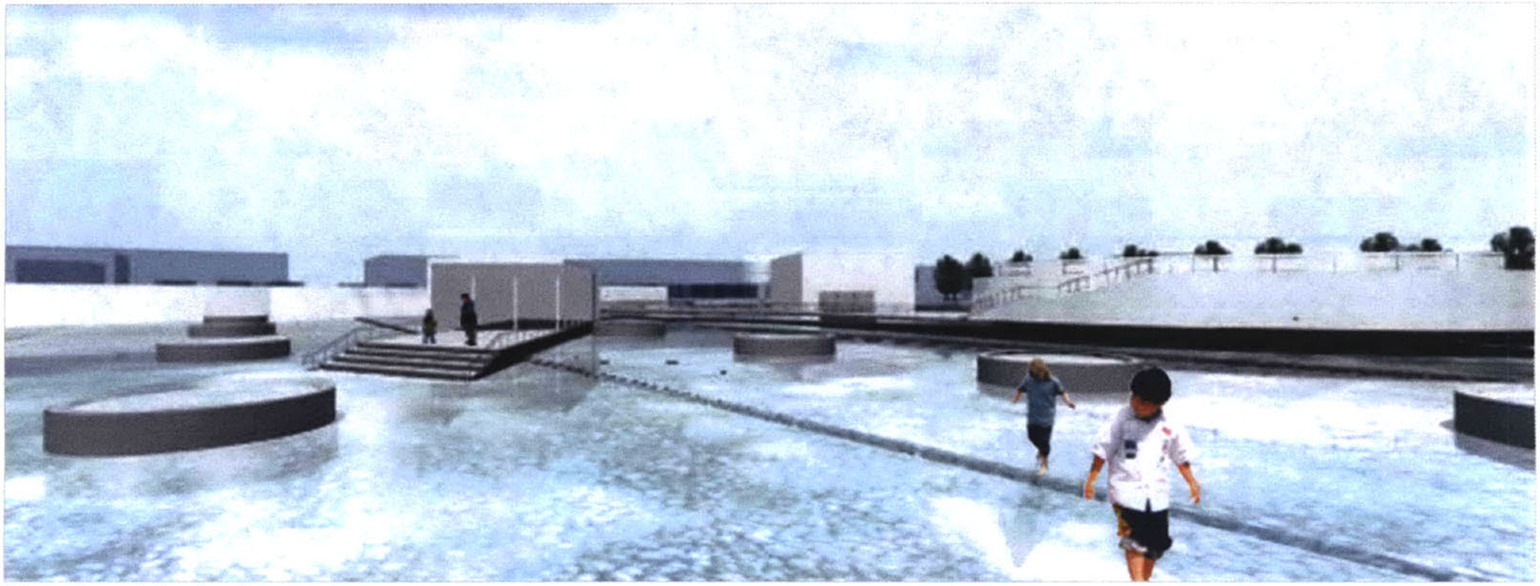
The surface of the water is co-planar with the surface of the library desk

Architecture



The interior view of the library

Perspective Drawing of the Site

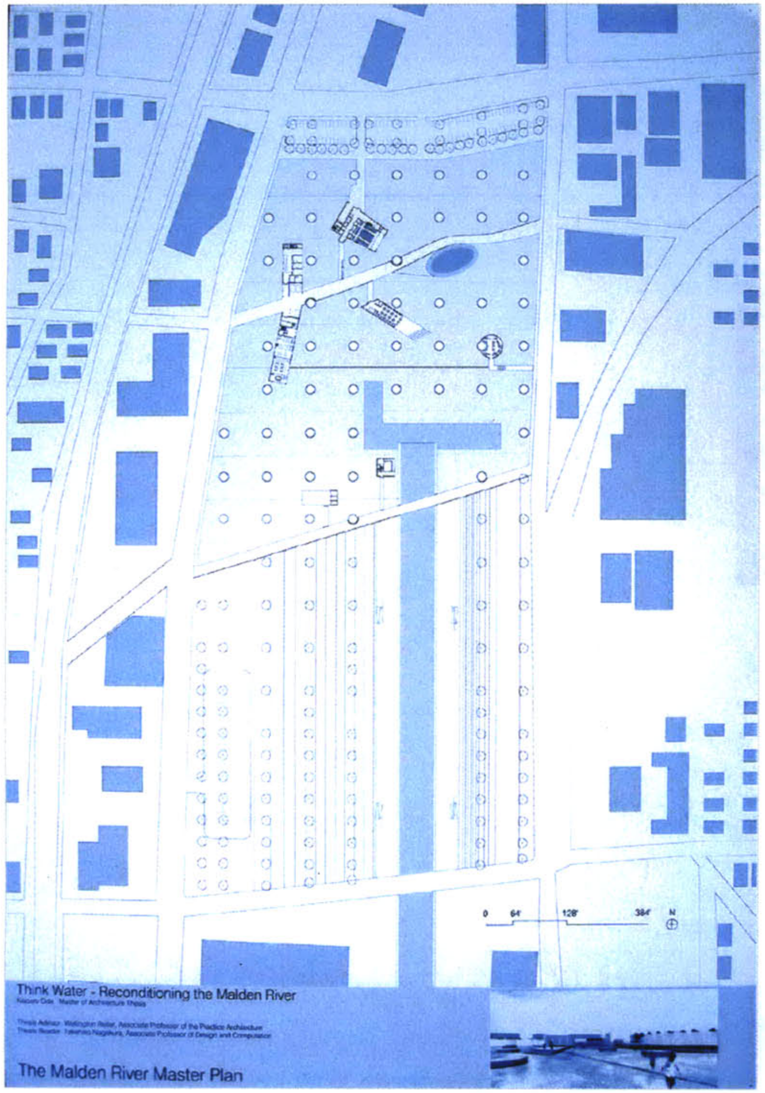


View fromt the teahouse in summer

Perspective Drawing of the Site

View of river bank looking towards

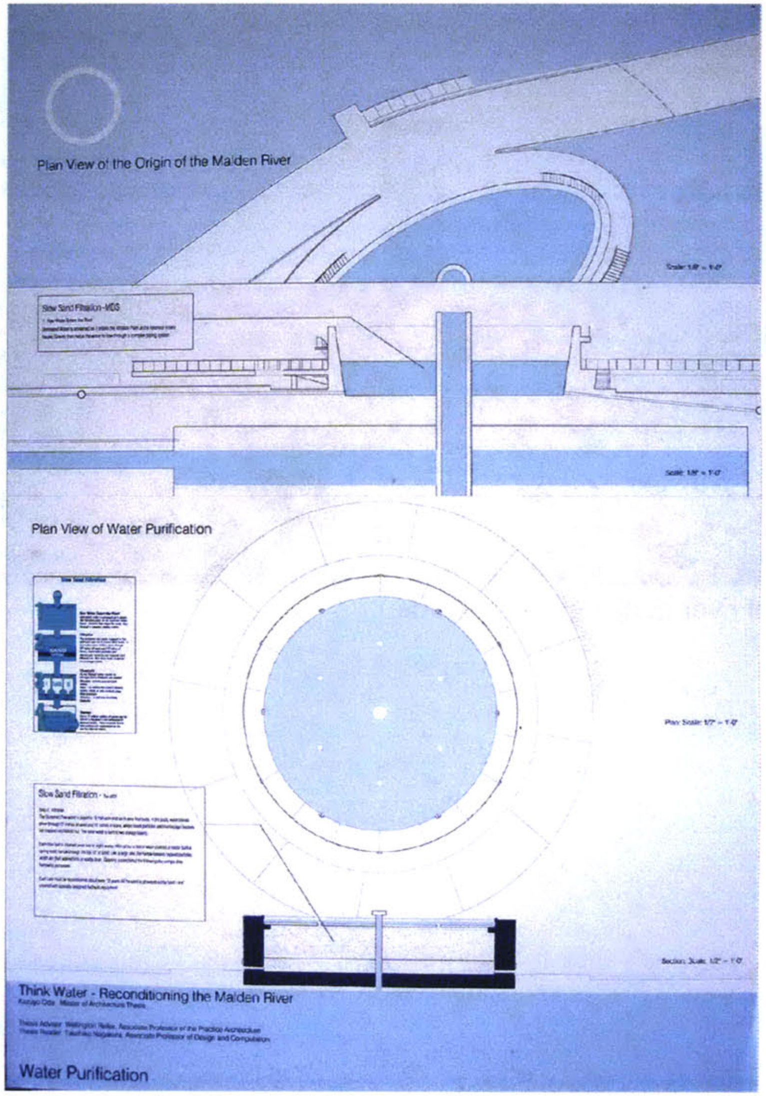
Presentation Boards



Think Water - Reconditioning the Malden River
Kazuyo Oda Master of Architecture Thesis

Thesis Advisor: Wellington Reiter, Associate Professor of the Practice Architecture
Thesis Reader: Takehiko Nagakura, Associate Professor of Design and Computation

The Malden River Master Plan

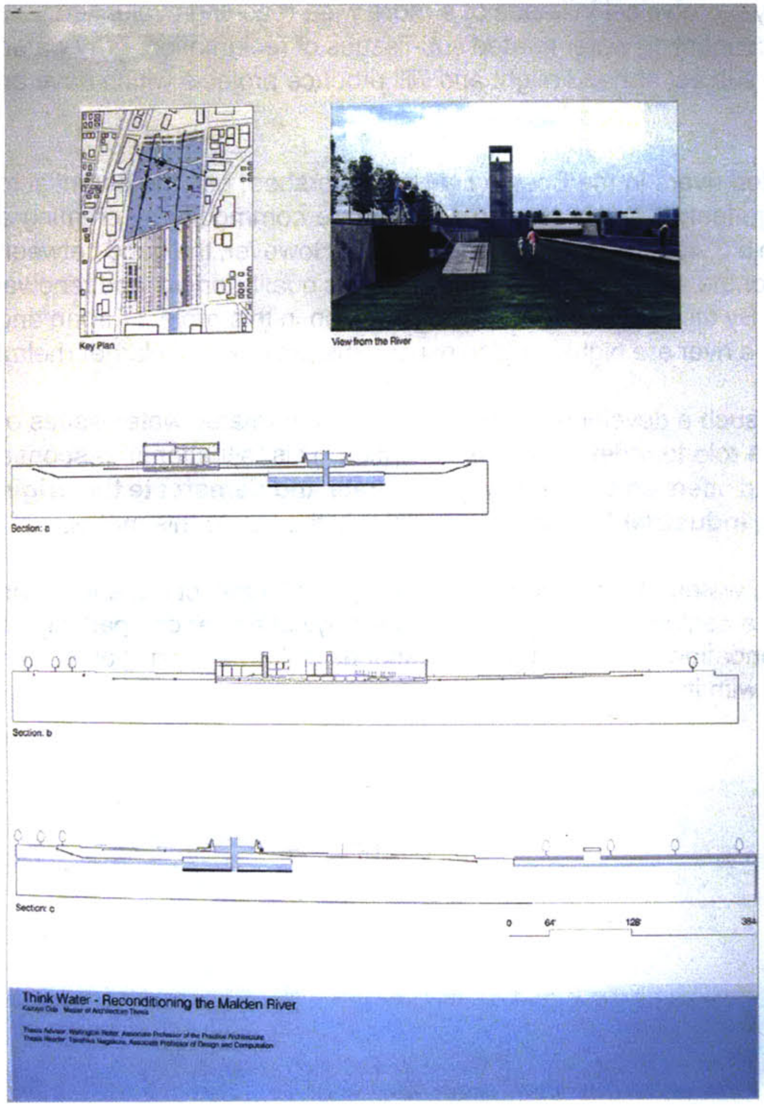


Think Water - Reconditioning the Malden River
Kazuyo Oda Master of Architecture Thesis

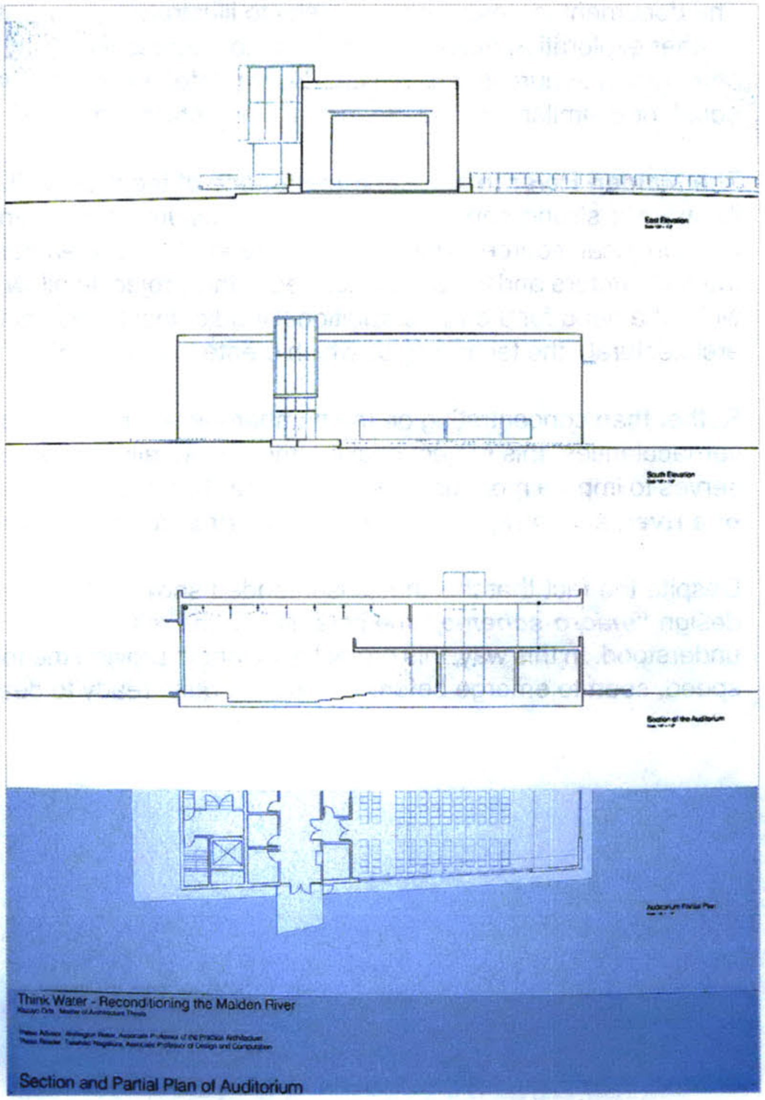
Thesis Advisor: Wellington Reiter, Associate Professor of the Practice Architecture
Thesis Reader: Takehiko Nagakura, Associate Professor of Design and Computation

Water Purification

Presentation Boards



Think Water - Reconditioning the Malden River



Think Water - Reconditioning the Malden River

Section and Partial Plan of Auditorium

Conclusion

The documented design herein seeks to illustrate a potentially prototypical instance of a more wide reaching evaluation. Further exploration must be considered to address the many connecting water related sub- issues of reclamation, gray water, other ground sources, and waste. Other related skews on the subject at hand might and will produce projects which have an equal, or disimilar results both formally and philisophicaly.

The **Malden River in Massachusetts,** one of the most polluted rivers in the Boston Harbor Watershed, has the potential to illustrate a strong connection between a cultures consuming lifestyle and a more precious, rare commodity by creating a mteaphorical "source." This project is intended to be seen from a distance, a mirror for our culture. However, the bond between the architecture and the site is restored in this project to allow for the a new understanding of waters quality, origin, and renewal without a need for the more traditional load of local precident. By utilizing two scales of intervention in this project (urban and architectural), the technologies which create the "source" for the river are highlighted to expand the project into a larger rhelm.

Rather than concentrating on the numberous technicalities of such a development and the many sub-related water issues or vernacularities, this project seeks a more culturally interpretive role to redefine a global situation. This "situational" response serves to imply a more universal demonstration of problems and offers an opportunity to **celebrate and demarcate the origin of a river,** and to **rejuvenate a water front and surrounding industrial landscape.** Contrast is the key to this model.

Despite the fact that this thesis is intended show some link to water, history and culture through an architectural and urban design ***"macro-scheme,"*** the potential for the rejuvenation of a neglected industrial site at the edge of a river can partially be understood. In this way, this project is meant to provide the foundation for a typology which speeds toward a civilization at high speed, soon to emerge before a world not quite ready to deal with its reprocussions.

December 13, 2002

Bibliography

Barlow Maude, Clarke Toney, Blue Gold – The fight to stop the corporate theft of the world's water, The New York Press, Printed in Canada

Dreiseitl Herbert, WATERSCAPES – Planning, Building and Designing with Water, published by Brikhauser – Publisher for Architecture in 2001, printed in Germany
Watts Andrew, Modern Construction Handbook, Springer-Verlag/ Wien, printed in Austria, 2001

Kirkwood Niall, Manufactured Sties, Island Press, Washington, DC, in 1998

Journals and Periodicals:

Gausa Manuel, Quaderns: Water-Land- TIERRA – AGUA Sevivios Libres de publicidad tecnica SA in 2001

VIA architectura, Agua Water, Published by Colegio Official de Arcuitectos de la Communidad Valenciana, in 2001
Dreiseitl Herbert, WATERSCAPES – Planning, Building and Designing with Water, published by Brikhauser – Publisher for Architecture in 2001, printed in Germany
Architectural Record, "Drain It Right" Wetlands for Managing Runoff, issue of August, 2001, published by the Mcgraw – Hill companies

Web

Water purification: www.globalwater.com

Cambridge Water Department: www.ct.cambridge.us/~water

Rainwater Harvesting: www.sustainable.com.au/rainwater.html

Water Recycling: www.waterrecycling.com

Enviornmental Protection Agency: www.epa.gov

MWRA: Massachusetts Water Resources Authority: www.mwra.com

The MDC: www.themdc.com

Reference Credits:

(1) Definition of Water : from Webster Collage Dictionary page, 12

(2) Definition of "hydrologic cycle," page 13 from Northern Arizona University · College of Engineering & Technology · Department of Civil & Environmental Engineering: http://www.cet.nau.edu/Projects/SWRA/research.html

(3) Definition of "Watershed" , page 15 is from Massachusetts Watershed Initiative. http://www.state.ma.us/envir/mwi/watersheds.htm

(4) All the Information and diagrams regarding " the history of drinking water," from page 16 and 21 are provided by EPA:The History of Drinking Water Treatment: EPA : www.epa.gov/safewater/sdwa25/sdwa.html

(5) Information of "Cleaning the filters" - Slow Sand Filteralation / Rapid Sand Filterlation, page 22 and 23 is provide byThe Metropolitan District (MDC): www. themdc.com/slowsand filterlation/ rapid sand filterlation.htm

(6) New Technology "Ultraviolet technology" information is porvided by Trojan Technologies Inc, and William L. Cairns,. http://www.trojanuv.com/page 24, on the left half

(7) , (8) © Copyright 2002 Chemviron Carbon. All Rights Reserved. Webmaster, page 24 on the right half http://www.chemvironcarbon.com/carbon/definition/adsorption.htm.

(9), (10), (11), (12), : Wetlands: Nature's Water Purifiers By Edward B. Adams on page 25 http://cru.cahe.wsu.edu/CEPublications/eb1723/eb1723.html

(13) All the text Information provided on page 28, and page 29 is by MASSACHUSETTS WATERSHED INITIATIVE http://www.state.ma.us/envir/mwi/watersheds.htm

(14) Information regarding the Malden River: http://www.mywatershed.com/cha/mys1.htm /http://www.mywatershed.com/cha/mys12.htm

(15) City infor regarding the Malden, Medfrod and Everett: http://www.ci.malden.ma.us/ http://www.ci.medford.or.us/, and http://www.ci.everett.ma.us/

(16) Definition of "Brownfield" and other related infomation on page31 is porvided by (Journal of Environ,ental Planning and Management, V43(1). p49-69. Jan 200.)"

(5) Reference on the Slow Sand Filterlation on page 34 and 35 is provided by The Metropolitan District (MDC)

Image Credits:

(1) Image of bottled water http://www.nature.com/nsu/020402/images/water_160.jpg, page 7

(2) image of water drop from website:www.hd.org/Damon/photos/natural-science, page 12

(3) image of Hydrologic Cycle from web: http://www.cet.nau.edu/Projects/SWRA/research.html

(4) image of watersheet © Canaan Valley Institute 2001www.canaanvi.org/images/assistance/ watershed

(5) p.16, history of drinking water: EPA- U.S. Enviornmental Protection Agency: www.epa.ogv/safewater/sdwa25/sdwa.html

(6) p.17, history of drinking water: EPA- U.S. Enviornmental Protection Agency: www.epa.ogv/safewater/sdwa25/sdwa.html

(7) p.18, diagram (7): EPA- U.S. Enviornmental Protection Agency: www.epa.ogv/safewater/sdwa25/sdwa.html

(8) p.19, diagram (8): a typical water treatment plant: EPA- U.S. Enviornmental Protection Agency: www.epa.ogv/safewater/sdwa25/sdwa.html

(9) diagram (9) of "Slow Sand Filtration" and "Rapid Sand Filtration" p.22 &23, provided by Metropolitan District Commission (MDC): http://www.themdc.com

(10) image of Activated Carbon (p. 24) provided by ©Copyright 2002 Chemviron Carbon

(11) image of Land and Person Force provided by ©Copyright 2002 Chemviron Carbon

(12) image of waterlillies is from web: http://cru.cahe.wsn.edu "Wetlands: Natures Water Purities by Edward

(13) diagram (13) provided by: http://cru.cahe.wsn.edu "Wetlands: Natures Water Purities by Edward

(14) diagram (14) provided by: http://cru.cahe.wsn.edu "Wetlands: Natures Water Purities by Edward

(15) diagram (15) provided by: http://cru.cahe.wsn.edu "Wetlands: Natures Water Purities by Edward

(16) Aerial view provided by: http://www.terraserver.com (p.28)

Other Resource

Reference

Jim Ritta
Production Manager Water Department City of Cambridge

Jon Norton

Conservation Department at MWRA