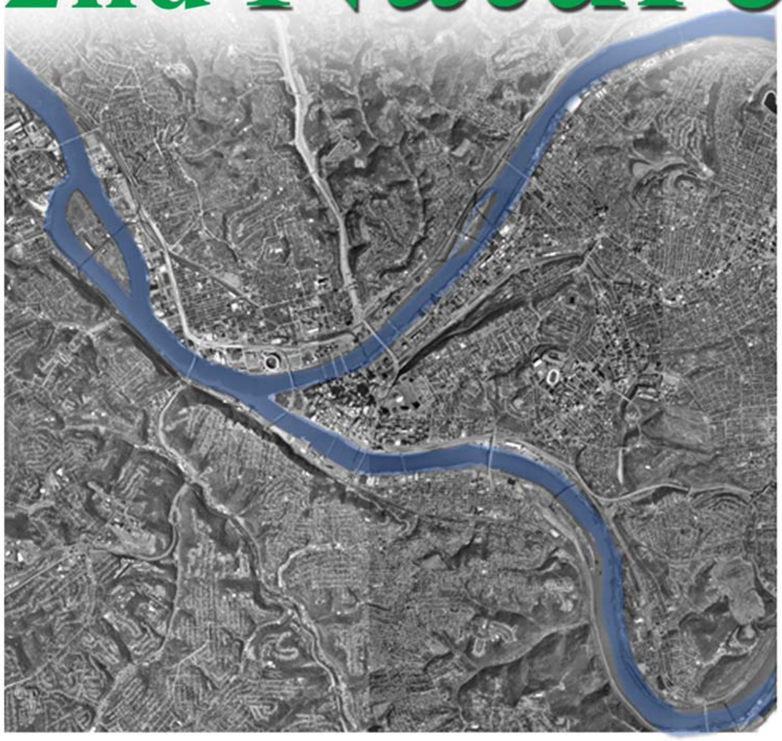
April 30, 2001

# Riverbank Conditions
# Phase I Report – Year 2000

**3Rivers 2nd Nature**

**Art**
**Ecology**
**Community**



**The STUDIO for Creative Inquiry**
**Carnegie Mellon**

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Matt Graham is a nationally recognized GIS Database authority. He is an expert at planned long term databases which enable consistent and dynamic updates, resulting in maximum decision support systems. Working with the research team, Matt developed the GIS concepts and the organizational structure to accommodate maximum automation of the diverse databases emerging from field work. His work increases consistency in reports, maps, and decision making.

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**Partners in this project include**

**3 Rivers Wet Weather Incorporated** (3RWW)
**Allegheny County Health Department** (ACHD)
**Allegheny County Sanitary Authority** (ALCOSAN)

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For more information on the 3 Rivers – 2nd Nature Project, see http://3r2n.cfa.cmu.edu

If you believe that **ecologically healthy rivers are 2nd Nature** and would like to participate in a river dialogue about water quality, recreational use and biodiversity in the 3 Rivers Region.

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# 3R-2N Riverbank Conditions Report Phase 1 – 2000

# 3R-2N Riverbank Conditions Report Phase 1 – 2000

## Riverbank Conditions and Access to the Three Rivers in the Emsworth Pool

**Prepared by Suzy Meyer, landscape architect**

Revised and Edited by Tim Collins, Project Director

**Abstract**

One intent of 3 Rivers – 2nd Nature's (3R-2N) is to define and examine the meaning of Green Infrastructure[1]. This report addressing bank conditions compliments the biotic assessment (undertaken by Sue Thompson Ph.D. in parallel to the bank study) and establishes baseline conditions. The research team of Suzanne Meyer (landscape architect), and Reiko Goto (artist) examined riverbank materials, indications of public access, and extant floodplains along the three rivers within the Emsworth Pool. Data collected on riverbanks document material composition, condition of materials, bank height, bank steepness, and formal and informal points of access.

Fifty miles of riverbanks were inventoried between July and August 2000. This data-intensive survey also included a botanical assessment of all riparian vegetation. To manage the geographic scope of the project, the green-infrastructure team used 1/10 mile study units which became the critical link uniting geography with data in our use of Global Positioning Systems (GPS) with Geographic Information Systems (GIS).

Given the post-industrial conditions which result in disturbed ecosystems, we separate form (bank materials, material conditions, bank steepness, bank height) from function. Throughout this document, we will refer to physical characteristics as *form* and the interaction between plants, soils and water as *function*. With the assessments done and data collected, spatial analyses in GIS is underway to study spatial relationships between these significant layers of information. There are two categories of function: humanistic (access, land use) and naturalistic or floodplain (ecological). Floodplain functions are indicated by hydric (moist) soils and the range of plant species likely to be found in those soils. Plants which are adjusted to moist soils are described as obligate (requiring moist soils) and facultative (able to survive in soils which alternate between wet and dry conditions). This will be confirmed at a later date through GIS comparison of banks and obligate wetland species identified in the botany study.

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[1] Green Infrastructure: Landscapes, soils, microbes, plants and other features of a natural environment which provide functional benefit to human communities through biological and physical process.

**Introduction**

This report is phase one, year one of a five-year study of the riverbanks of Allegheny County. Two members of the project team are studying specific elements of the Three Rivers and their attendant corridors. A river corridor is also known as a *riparian zone.* Forman offers a useful definition of the riparian zone as "a strip of vegetation that encloses a channel with flowing water. The corridor may only include the channel and its adjacent banks, or may be wide enough to include a floodplain, hill-slopes, and adjacent strips of upland."[2] This report specifically focuses on the materials, form, and to some extent the function and use of the river corridor. An accompanying report focuses on the woody vegetation and biodiversity of our corridor

The concept of analyzing urban systems for ecological form and function was first broached in the discipline of landscape architecture by Ian McHarg in 1969.[3] In his forward to McHarg's book Lewis Mumford notes "McHarg's emphasis is not on either design or nature by itself, but upon the proposition ***with,*** which implies human cooperation and biological partnership."[4] McHarg's groundbreaking work targets the genius of place. The work focuses on a layered analysis of climate, geology, physiography, hydrology, vegetation, wildlife, and land use, seeking the dominant natural features as foundation concepts for regional planning. Thirty years later, the National Science Foundation would begin to conduct the first long term studies of urban ecosystems, which place humans as an essential organism within the ecosystem, rather than as an outside force imposed upon the natural system.[5]

Mcharg clearly states the value of studying ecosystems in the context of urban areas: "When cities are built upon beautiful, dramatic or rich sites, their excellence often results from the preservation, exploitation and enhancement, rather than obliteration of this genius of the site."[6] In many ways this "genius of site" is the core philosophy behind the 3R-2N project. We are seeking to define and then understand the value of the natural opportunities inherent to our post-industrial riverfronts. McHarg provides significant models for our effort, from this core concept, to a detailed method of overlay analysis, proving influential today in thinking about the use of GIS in landscape analysis. This report

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[2] Forman, R. T. T., (1997) "Land Mosaics: The Ecology of Landscapes and Regions", Cambridge University Press, N.Y., N.Y., P. 208

[3] McHarg, I.L., (1969) "Design with Nature", The Natural History Press, Philadelphia, PA, P. viii

[4] Ibid.

[5] In 1998 two Long Term Ecological Research (LTER) programs began in Baltimore Maryland and Pheonix Arizona. They were the first studies within this program to move into urban settings.

[6] Ibid., 175

provides the design goals relevant to site planning. The goal is to move design away from a relationship in *opposition to* nature, and towards an integrated relationship *with* nature.

Recently landscape architect Michael Hough has taken up the mantle of urban ecological analysis and design. He is an eloquent spokesperson for the "ecological restoration" approach to damaged landscapes. Ecological restoration examines the existing and historic form and function relationships in each natural system. If the hydrology, drainage and soils (forms) are intact, the ecological restorationists' charge is specific, to facilitate the return of the historic organisms and functions to the ecosystem. If the hydrology and soils are largely disturbed, (minimal form nor function) the restorationist is faced with preserving natural sections, conserving endangered species where-ever possible, and restoring form and if possible function to the ecosystems. The primary goal is to knit the larger system and its inter-relating network of biological corridors back together in some meaningful way. The secondary goal is to provide people with a new point of engagement with nature, one that is restorative and decidedly urban. Plant Physiologist and noted restoration ecologist William Jordan, describes this idea in terms of gardening:

> If gardening provides a model for a healthy relationship with nature, then restoration is that form of gardening concerned specifically with the gardening, maintenance, and reconstitution of wild nature, and is a key to a healthy relationship with it.[7].

The work of the 3R-2N team is intended to instigate a dialogue about the remnant ecosystem functions of our area and the potential application of a restoration ecology approach to our urban waterfronts.

From July through August 2000, Meyer and Goto worked together to document the physical characteristics of riverbank conditions and public access points within the Pittsburgh Pool[8]. This study was to develop baseline documentation of riverbank conditions. The following questions guided the investigation:

- What kind of materials are the riverbanks made of? What condition are those materials in?
- What are the physical characteristics of the riverbanks--how tall? How steep?
- How accessible is the river from the land? How many public access points are there?

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[7] Jordan, W. R., (1994) "Sunflower Forest: Ecological Restoration as the Basis for a New Environmental Paradigm" in "Beyond Preservation: Restoring and Inventing Landscapes" Eds. Baldwin, A. D., De Luce, J., and Pletsch, C. University of Minneapolis Press, Minneapolis, Minnesota. Subsequently published in (2000) "Environmental Restoration: Ethics, Theory and Practice", Ed. Throop W., Humanity Books, of Prometheus Books, Amherst, N.Y. P. 206

[8] The Pittsburgh Pool is also referred to as the Emsworth Pool, after the Emsworth lock and dam on the Ohio River, designed and managed to maintain a 710-foot elevation between Emsworth and each of the first locks and dams on the Allegheny and Monongahela Rivers.

- Are there tracts along the river that demonstrate floodplain form and/or function?

## Materials and Methods

**General**: Almost 50 miles of riverbanks and islands were assessed during July to August 2000 from an open 16-foot boat that slowly traversed pre-determined 0.10 mile study units using a handheld Global Positioning System (GPS) unit for navigation. In addition, GIS maps incorporating aerial photos, road layers, and study unit points were available as a visual check for GPS readings. A total of 499 units were surveyed with approximately 10-20 minutes allotted to each unit. Typically each unit was traversed three times, twice at a distance of 1-5 m from the riverbank -- to identify individual plants -- and once from a distance of 5-10 m -- to identify bank materials and determine steepness (angle of slope), and public access, and floodplains. Identifications and determinations were made visually from the boat, but landings and near-shore approaches were made to check difficult-to assess sites. Riverbank conditions were documented with photographs.

GPS Points: Consistent river GPS navigation points for each 0.10 mile unit were created by first tracing the river edge from aerial images into a consistent polyline and then distributing perpendicular objects at the desired interval (0.10 mile) along the river edge. Each intersection point was assigned a unique identification code, indicating river A (Allegheny), M (Monongahela), O (Ohio), (I added for Islands), side of river -- facing downstream-- L (Left) or R (Right)), and a unique number ascending upstream. These point locations were converted from aerial UTM17 coordinates to latitude and longitude, and the latitude/longitude points (with identification codes) were loaded into a GPS unit. While in the field, navigation to points was established via GPS, to indicate the beginning and end of each study unit. This navigation point system was implemented using double precision techniques with Total Fit (by Landbase Systems) and FME (by Safe Software).

**Specific**: The following data sets were collected using a standard field form (see Appendix 1) the following items were analyzed and reference to the .10 mile Points for all study areas.

- Bank Materials
  - Concrete
  - Steel
  - Stone
  - Brick
  - Gabion
  - Wood
  - Fill/Rubble
  - Soil and Soil Conditions
- Bank Steepness
- Bank Access
- Bank Height Range
  - Average Height
- Floodplain hydrologic function indication
- Reference
  - Notes
  - Photographs

**Work Products: Data and Information**

Data and information are two different things. Data is the systematic collection of specific parameters on a given topic. Information, on the other hand, is the coalescing or analyzing of data -- making it useful for purposes of education, increasing a knowledge base, and/or decision-making. Data alone is not terribly useful; information derived from data, if well tabulated and well designed, can be very useful for stakeholders and decision makers.

The riverbank work in the 3R-2N project puts forth three important contributions. The first of these is the fieldwork that generated original data collection on riverbank conditions and access. This data collected on fishing access points updates and adds value to the 1991 data sets in Recreational Use Survey and Valuation of Recreational Use Types for Portions of the Allegheny, Monongahela, and Ohio Rivers.[4] Second, spatial analyses between bank conditions and botany studies render an accurate, high-integrity baseline of current conditions. Finally, information (derived from the team's data and analyses) is prioritized and graphically represented for both the expert and the citizen stakeholder.

The baseline documentation is presented in the form of maps, bar charts, and pie charts. Maps generated in GIS, provide a very large-scale view of the whole system as well as closer examinations along one-mile stretches of river. Bar charts using one vertical column per study unit, show how riverbank materials, for example, change over the course of each riverbank, whether it is 4.5 or 11 miles long. Pie charts give an immediate impression of percentages--how much of X, Y, and Z occur in a given area. An interactive version of the executive summary will soon be made available on the 3R-2N website.

## Project Description

## I. Riverbank Conditions

In the protocol development stages of this survey of green infrastructure we decided that documentation of the riverbanks and their relative physical condition was the first place to start. Such a baseline, we thought, will be useful when applied to ecologically sensitive waterfront planning and the ecological restoration of riparian habitats for wildlife. Baseline data on riverbank height and steepness would help in an eventual long term understanding the morphological character and dynamics of the river corridors.

### a. Materials

The riverbank study documents physical materials that make up riverbank slopes, especially those meeting the water's edge. Along the course of the three rivers within the Pittsburgh Pool, seven different materials meet the rivers' edge: stone block, concrete, wood, steel, fill/rubble, gabion, and soil.

*Stone block* refers to large blocks of rough, hand-hewn stone laid as retaining walls or bridge buttresses.

*Concrete* varies in its application from a tightly controlled formal edge like the one found at Point State Park, to a broad wash of concrete poured over soil and rubble that spills beyond the river's edge into the water.

*Wood*, in the few places where it occurs, tends to be in the form of relatively tall, retaining walls set back from the river's edge.

*Steel* used for retaining walls primarily on active and retired industrial sites. Steel is sometimes used as a primary structural element of retaining walls. It is most often present in the form of recycled steel barges (no longer sea-worthy) which are sunk and often filled with soil and plants at the river's edge. In a few instances barges are piled one atop another to create a vertical edge of considerable height.

*Fill/rubble*, refers to a wide variety of man-made materials used primarily as urban fill to secure more land for buildings, industry, or transportation above the river's edge. Fill/rubble, for example, refers to any combination of slag, crushed limestone, brick, stone chunks, pieces of concrete slabs, or soil mix.

*Gabion* are boxy wire cages holding crushed limestone used to stabilize steep banks and create retaining walls.

*Soil* whether naturally occurring, or placed in the recent past as fill material, is the most natural material on the list of riverbank materials.

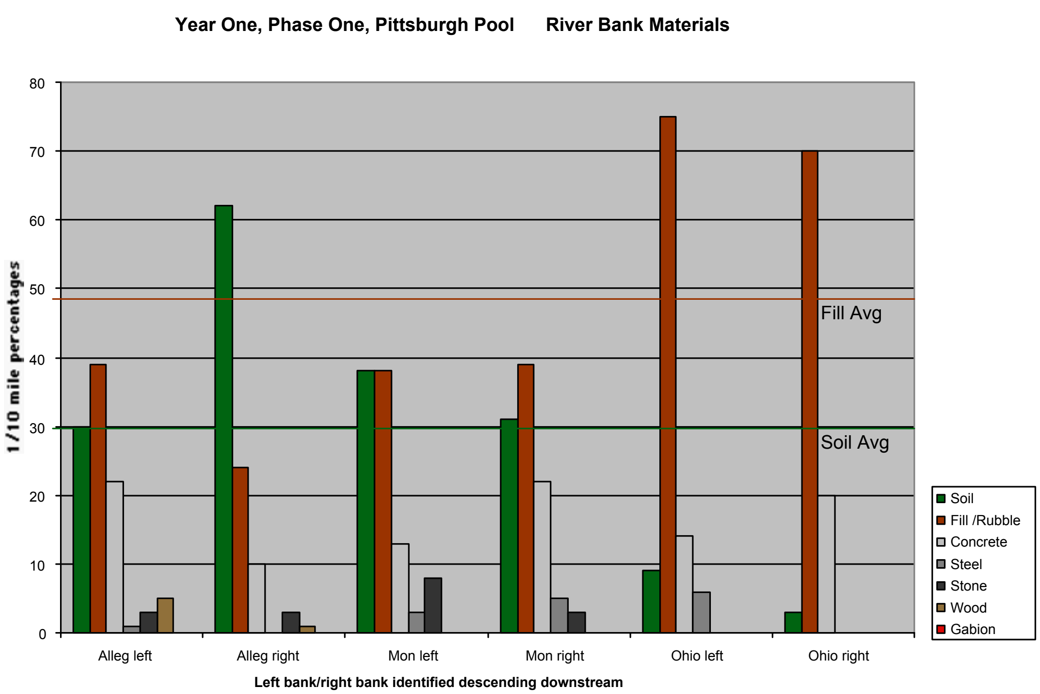
Table 1 and Chart 1 (on the following page) give percentages of different materials that make up riverbanks. Bar charts showing spatial distribution of materials in 1/10 mile units for each riverbank are attached to the back of this report. Planners interested in ecologically sustainable riverfronts may find it useful to know that the river bank with the most soil by far (62%), is the right bank (descending) of the Allegheny River.

**Table 1. Material Composition per River Bank (%)**

Left and Right Bank orientations are in the river's downstream direction.

| | Alleg left | Alleg right | Mon left | Mon right | Ohio left | Ohio right |
|---|---|---|---|---|---|---|
| *Soil* | 30 | 62 | 38 | 31 | 9 | 3 |
| *Fill /Rubble* | 39 | 24 | 38 | 39 | 75 | 70 |
| *Concrete* | 22 | 10 | 13 | 22 | 14 | 20 |
| *Steel* | 1 | | 3 | 5 | 6 | |
| *Stone* | 3 | 3 | 8 | 3 | | |
| *Wood* | 5 | 1 | | | | |
| *Gabion* | | | | | | |

**Chart 1. Material Composition per River Bank (%)**




For the purpose of geographic context, landmarks in the down river direction include:

| | |
|---|---|
| Allegheny left: | Butler, Lawrenceville, the Strip, downtown, Point State Park; |
| Allegheny right: | Sharpsburg, Millvale, Route 28, Heinz Plant, two new stadia; |
| Monongahela left: | Kennywood, Sandcastle, Homestead, South Side, Station Square; |
| Monongahela right: | Braddock, Glenwood, Hazelwood, Nine Mile Run, parking wharf, Point State Park. |
| Ohio left: | Duquesne Incline, Kaiser Terminal, Chartiers Creek, McKees Rocks. |
| Ohio right: | Carnegie Science Center, old penitentiary, Alcosan, Emsworth Lock & Dam |

**b. Condition of Materials**

As riverbank materials were identified the varying states of physical condition were documented. Riverfront materials are in constant contact with water, its seasonal fluctuations, and occasional ice. Wave dynamics (emanating from wake activity, freeze/thaw conditions, and/or standing up to industrial river-based activity) take a toll on the initial strength, endurance, and integrity of all bank materials.

A condition rating was assigned to the materials found in each 1/10 mile study. Three ratings are used to assess the current physical condition of riverbank materials:

*a* = strong, high integrity;
*b* = signs of stress, some wear;
*c* = significant wear, deteriorating, crumbling, falling, failing.

*A Note on Materials and Plant Species Distribution*

Field analyses to date indicate that non-native, or invasive species tend to be most prolific on sites with higher degrees of disturbance, i.e. recent earth moving activity or non-soil substrates. A series of GIS analyses, comparing soil to botany will confirm these indications.

**c. Steepness**

Steepness, also a qualitative assessment, has bearing on a riverbank's capacity to act as a floodplain, and is a factor in being able to access the river from landslide. Riverbank steepness references the general morphological character of a river valley, however, in the historically industrialized river valleys of the Pittsburgh Pool, human activity has greatly altered the riverbanks and changed their natural angles to serve human needs for transportation, flood control, and more usable land, hence urban fill.

Steepness has three ratings:

*fnf* = flat, near flat, implies little effort in dealing with slope to reach the river;
*m* = moderate slope means some attention to slope and foot placement to get the river, light scrambling, not arduous;
*vnv* = vertical, near vertical implies that the steepness for a pedestrian is generally too great, starting at 45degrees up to 90 degrees.

**d. Height**
Height was measured from a boat in six-foot increments. Using this human scale simplified the process of visualizing and assessing riverbank height. Height recorded in the GIS is categorized from 0-6 feet, 7-12 feet, up to 37-42 feet. (The highest bank is approximately 42 feet above river level and occurs on the Allegheny left descending bank, one-half mile below Lock and Dam 2 near the Highland Park Bridge.

These qualities of *height*, *steepness*, and *materials* combine to give us an evaluation of pedestrian-based, public access to the rivers from the land.

## II. Access

Public access to the rivers is in a state of constant change. Access is defined in the 1996 Recreational Use Survey as foot access from the top of the bank to the bottom of the slope (where the land meets the river).[9] For our study, the primary objective was to build on the survey to show the informal and opportunistic recreation sites and their locations along the three rivers. Since the 1996 report was produced, significant waterfront development has occurred. Public access is considered an important element of waterfront design. Additionally, passive or "unplanned" waterfront use has increased and a range of bank conditions -- from concrete infrastructure to remnant floodplain -- are being used.

**a. Classification**
This assessment was taken from boat-based observations and was often indicated by the visual evidence of footpaths, firepits, chairs, worn beaches, fishing pole holders, and people. Evidence being absent, access was ranked subjectively based on the potential of a person to gain access to the river's edge. Factors taken into account were combinations of steepness, height, materials, and density of under-story vegetation. The following classifications were used to document access potential of each 1/10 mile unit:

*E* = easy access

*M* = moderate effort to foot placement would be necessary to get to the river

*I* = inaccessible due to retaining walls, or due to various combinations of steepness, height, and under-story vegetation.

How people get to the tops of riverbanks from the land was not analyzed. We know from 1995 aerial photography that [active] railroad tracks paralleling the tops of riverbanks are a major obstacle to pedestrians attempting to reach all three rivers. Observed from the boat, it was noticed that many small, but actively used fishing sites are only accessible from above by walking along or across a railroad right-of-way.

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[9] Ibid.

**b. Adding Value to Existing Data**

In 1996 ORSANCO, the Pennsylvania Department of Environmental Resources, and Pennsylvania Fish & Boat Commission published Recreational Use Survey and Valuation of Recreational Use Types for Portions of the Allegheny , Monongahela, and Ohio Rivers. Their study began with the 1991 inventory of all site of recreational activity on the Ohio River to the state border, and up both the Allegheny and Monongahela Rivers to the third lock and dam on each. In this 80-mile river corridor, they inventoried 158 public and private access points to the rivers and classified them into: fishing access, boat ramp, marina, canoe club, rowing club, private docks, island, park, and slalom course. In the Emsworth Pool alone, our team's area of interest, the Recreational Use Survey identified 46 public and private points of recreation access--28 of which were fishing access and riverfront parks. 3R2N's study counted 58 fishing and park access points, adding 30 to the original data set, which was developed in 1991.

Observing the riverbanks from a boat, consultants working on the Recreational Use Survey located evidence of people using riverfront sites: empty cans of bait, firepits, footpaths. When they identified an area of use, they beached the boat and climbed to the top of the riverbank to locate the nearest road and parking areas that allowed the recreational user to access that point on the river. (This would enable interviewers at a later date to drive close to the site in order to survey recreational users). They also videotaped the shorelines.

Our boat-based approach was not dissimilar. In documenting riverbank conditions and riparian vegetation, we put in time-intensive efforts (approximately 12 minutes for three passes) of each 1/10 mile study unit. Though ten years apart, our methods for determining fishing access points were nearly identical. With this in mind we asked, why are there *twice as many* fishing access points? The fact that it is ten years later is explanation enough for Bob Shima, who worked on the Recreational Use Survey. [10] He suggests the local perception of the river as an ecological system has shifted. According to Shima with regard to riverbank use, "the whole mind set is changing". He relates this to other factors as well: the increase in fish species and the dismantling of polluting riverfront industry in many places.

Table 2 and Chart 2 display percentages of existing or potential access to the water's edge from the land for each 1/10 mile study unit within the Emsworth Pool. Bar charts showing the spatial distribution of access per river bank are attached to the back of this report.

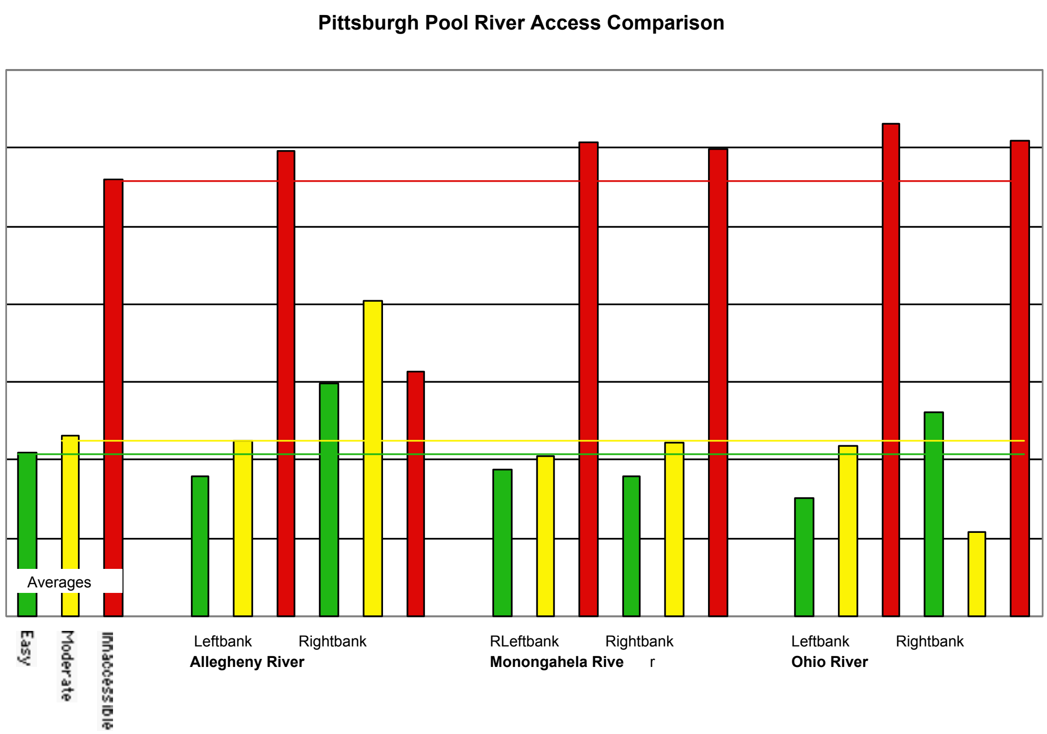
[10] Bob Shima conducted the access inventory while he was with Aquatic Systems Corporation, a sub-contractor to Terrestrial Environmental Specialists. Bob Shima is currently with Marion Hill Associates. (phone interview with Suzy Meyer on January 23, 2001)

**Table 2. Access per River (expressed in %)**

Left and Right Bank orientations are in the rivers' downstream direction.

| | Alleg left | Alleg right | Mon left | Mon right | Ohio left | Ohio right |
|---|---|---|---|---|---|---|
| *Easy* | 18 | 29 | 19 | 18 | 15 | 27 |
| *Moderate* | 22 | 40 | 21 | 22 | 22 | 11 |
| *Inaccessible* | 60 | 31 | 60 | 60 | 63 | 62 |
| | 100% | 100% | 100% | 100% | 100% | 100% |

**Chart 2. Access per River (expressed in %)**




*A Note on Steepness and Access*

One assumption at the beginning of the study was that steep riverbanks would preclude access to the rivers' edges. This turned out to be false in eleven study units where river banks classified *vnv* (vertical, near vertical) still provide relatively easy access to the river because of the presence of a usable staircase (often provided for maintenance access to sewer infrastructure). This is a commonly used means for accessing the river.

## III. Floodplains

The steep slopes and soft shale soils of Allegheny County are subject to the erosive forces of water, which determines dominant land forms and plant communities at the river's edge. Steep banks, shallow floodplains and looming hill sides typify our river corridors. These forms are much different than Ohio, for example, where the river is met by a wide-low flood plain, which results in the best farming soils. Some argue that the steep bank conditions of Allegheny County provided a form, which was ideal for the development of industrial uses of the riverfront. Today, as we consider the rivers for the remnant ecological value, we must evaluate the riverbanks for forms, which have potential for restoration, conservation, or preservation of ecological functions.

In the last two hundred plus years, land for transportation and industry sectors in Pittsburgh have been accommodated, expanded, and stabilized through means of riverbank modification and fill. River transportation programs, have resulted in the canalization of the rivers. The locks and dams, are intended to keep the river height consistent, mitigating both low flow and high flow/flood conditions. Despite this, the rivers continue to fluctuate in height. In a relatively undisturbed river corridor, floodplains occur between the river edge to the Ordinary High Water (OHW) mark. The Ordinary High Water mark is "a distinct line along the shore which has been established by fluctuations in water level, with enough frequency and duration to change the character of both the vegetation and the soil upland of the riverbed." [11] (OHW has not been determined in the Emsworth Pool.) Typically floodplain areas correspond to a 3-5 year flood. These flood events happen with enough frequency to create the soil and plant conditions indicated above. Because of the disturbed banks and materials, we have chosen to indicate potential floodplains based upon a formal physical characteristic: height. Next, we overlay the obligate and facultative wetland species (identified in the botany study) to provide us with an indication of functional interactions.

### a. Form

We decided on a single parameter because banks under 10 feet were considered to have the formal (that is to say physical) characteristics of a functioning floodplain with the potential for wet (hydric) soils and obligate and facultative wetland plant species.[12] Soils, slope gradient, deposition and vegetation were all considered during the field study. This section of the report will address the potential for water

[11] Reilly, R., (1999) "Ordinary High Water Determination, Mohoning River, PA Miles 0-11.85", U.S. Army Corp of Engineers

[12] Email Communication: Reilly, R., (2001) "There is on average a 7.6 foot difference between pool and ordinary high water at the Point in Downtown Pittsburgh, this corresponds to the two or three year storm". U.S. Army Corp of Engineers, Biologist."

flooding the surface of these urban river banks. Out of 365 study units along the Allegheny and Monongahela Rivers 50% are below ten feet in height. The widest floodplain, on the Monongahela River is approximately three hundred feet deep.[13]Bank heights were estimated in six-foot increments to achieve a height range. Average height was also recorded and used for this analysis. In addition, the research team took detailed sets of reference notes, describing each river section. Height recorded in the field ranged from 0-42 feet. (The highest bank is approximately 42 feet above river level and occurs on the Allegheny left descending bank, one-half mile below Lock and Dam 2 near the Highland Park Bridge.)

Table 3, and Chart 3 (on the following page) display bank height >10 feet as an indication of floodplain for each 1/10 mile study unit within the Emsworth Pool. The bar chart shows the islands as well.

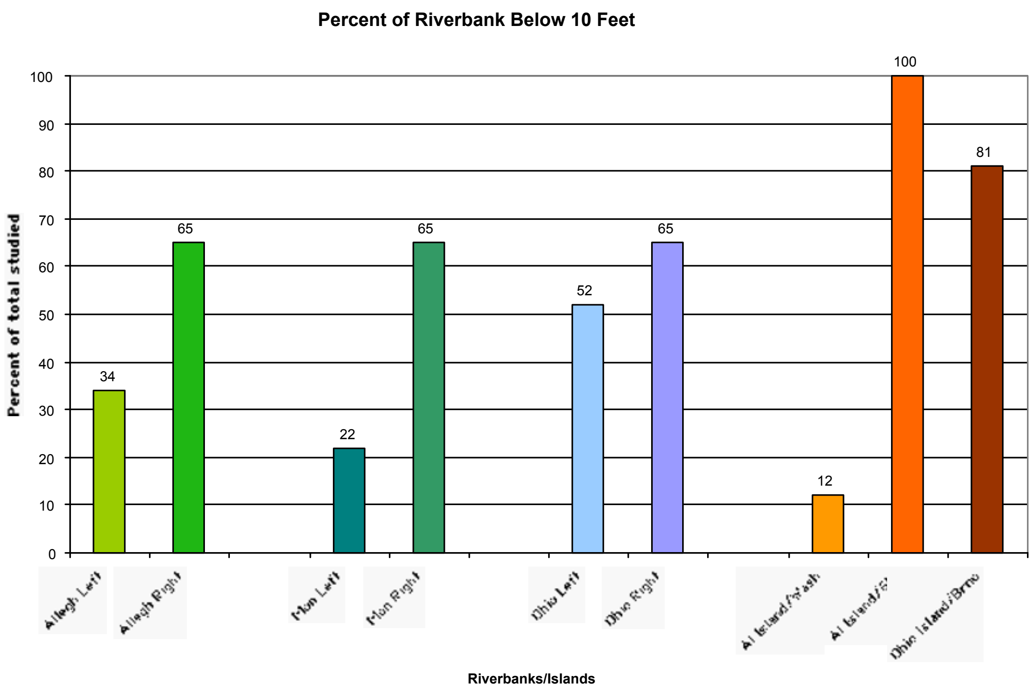
[13] Width and Area calculations are yet to be determined.

**Table 3. Less than ten foot bank height as an indication of floodplain (%)**

Left and Right Bank orientations are in the river's downstream direction.

| | Alleg left | Alleg right | Mon left | Mon right | Ohio left | Ohio right |
|---|---|---|---|---|---|---|
| *Banks Below 10 feet* | *34%* | *65%* | *22%* | *65%* | *52%* | *65%* |

***Chart 3. Less than ten foot bank height as an indication of floodplain (%)***




## b. Function

As previously described, an ecologically relevant flood plain exhibits both physical form (bank shape, plant materials) and function (biological and chemical interactions typical of hydric soils).

By editing the 1/10 mile botany data for obligate and facultative wetland species, projecting that data in GIS, and overlaying a coverage of our less than ten foot flood plain forms, we will be able to estimate the average high water, as well as the distribution of ecologically functioning floodplains throughout the pool.

**c. Form by Design** (without Floodplain Function)

Given the urban form of our study area, a number of sites exhibit floodplain *form* with little or no ability to support function *by design*. These are hard edged urban park conditions, which put the pedestrian in proximity to the water, yet typically ignore the potential of a riparian plants in adjacent lawns. Interesting and creative exceptions include – the Pittsburgh Cultural Trust's, walkway on the left bank of the Allegheny River, and on the opposing right bank, the planting by the Alcoa Corporation. It is easier to restore ecological function if the form is in place, than it is to remove fill to restore both form and function.

## IV. Summary

*Riverbank Conditions*

On the three rivers, riverbanks are made up of six "hard" materials (i.e. brick, stone block, concrete, wood) and one "soft" material (soil). Further upstream or downstream from the confluence at Point State Park, less concrete was found. The river bank with the most soil is on the Allegheny right bank descending.

The condition of these materials range from being in very good condition, to showing signs of wear, to failing, to falling. The last condition occurs infrequently. This indicates stable banks as would be expected in a river system composed of locks and dams.

*Access*

Fishing access points on the rivers have doubled in the last ten years. We are able to compare a 1991 recreational access inventory, to access data we collected in the summer of 2000. The result: fishing access points went up from 28 to 58. The reasons: fish species have increased in each river, polluting industries are increasingly absent from the riverfront, and perceptions have shifted on the part of residents towards their rivers.

*Floodplains*

The physical form of floodplains can be indicated by height. The function can be indicated by botanic identification of obligate and facultative wetland species, which would occupy soils within the ordinary high water mark (roughly corresponding to a 2-3 year flood). A subsequent analysis of the data from the bank study and the botany study will be required before we can clearly state the amount of functioning floodplains in the Emsworth Pool. It can be said that there is significant opportunity to restore flood plain functions, based on the fact that 50% of the study areas are within ten feet of ordinary low water.

**Recommendations for Further Study**

Though currently beyond the scope of our work, the following suggestions would add a wealth of context and information to the study of our modern green infrastructure landscape.

- Conduct an historic analysis of floodplains. South Side flats and North Side. How big were pre-settlement floodplains in the modern Emsworth Pool? Did or does the steep morphology of the river valleys allow for significant floodplains to take hold?
- Conduct an historic inventory of islands that no longer exist in the Monongahela, Allegheny, and Ohio Rivers. Were they removed for navigation purposes? Was there a plant inventory on any them? Were they pressed into use for agriculture?