phosphorous and other pollutants to stormwater runoff. Suggestions for the maintenance and enhancement of the ravine system include:

· Initiate programs under the Great Lakes Commission's Soil Erosion and Sedimentation Control grant program to undertake the maintenance and restoration of the Allen's Creek ravines
· Request new city standards and practices for installation of utilities in ravines and creek areas, to replace the usual 30' to 50' swaths cleared for trenches
· Establish designated conservation easements on creek ravines, based on the precedent set along the ravine near Edmund Place at West Huron Street

2. Wetlands

Wetlands offer many benefits to watersheds. Wet meadows and ponds slow the delivery of water to the main watercourses, allow percolation of water into the soils and vegetation, and improve aeration. By these means, they reduce the delivery of pollutants to waterways and also provide filtration of pollutants in the runoff. Consequently, wetland preservation and restoration is recommended in the Allen's Creek Watershed. An initial step is to undertake a functional assessment of the wetlands of the Allen's Creek watershed, including criteria for preservation, enhancement and restoration potential. Appendix I on page 45 presents identified potential sites for wetland restoration. In addition, it is recommended that the city implement property tax credits for individuals and others who undertake the restoration of urban wetlands.

3. Daylighting of Streams

Daylighting stream channels presents an option for restoring the Allen's Creek as a natural feature in the City of Ann Arbor, providing naturalized areas for human recreation and wildlife in the urban environment. Open stream channels provide numerous environmental and economic benefits, including improved water quality, reduced water velocities, and reduced risks from flooding (see Section IV.E.3 and Appendix H for further discussion). Enclosed sections of the Allen's Creek should be surveyed for potential sites for creek bed daylighting and restoration.

4. Greenway Development

Opportunities exist to create a greenway system through the Allen's Creekshed. Residents and community members within the Allen's Creek watershed may be receptive to the use of parklands within Ann Arbor for stormwater detention purposes if the process also enhances the recreation amenity of the parks. This greenway should be integrated into other city plans. For example, an Allen's Creek greenway could start from the planned greenway along the Huron River and run through downtown Ann Arbor all the way up to the University of Michigan athletic campus. Furthermore, the greenway could potentially branch out along Allen's Creek up through Ann Arbor's west side, linking existing parks (and perhaps creating new park spaces) along the creek system. Details regarding a potential plan for such a greenway are provided in Appendix J on page 46.

VII. Conclusion

Whether below or above ground, Allen’s Creek is a principal watercourse in the City of Ann Arbor with significant impacts on the city, its residents and businesses, and the Huron River. By weaving stormwater management into the fabric of urban development as described in the strategic plan, it should be possible to improve water quality, reduce risks and consequences from flooding, and preserve and restore natural features for less cost and greater benefit than expected from traditional structural and water treatment solutions.

This watershed plan challenges current popular ways of thinking about surface water runoff. The traditional means of managing stormwater, by enclosing it for conveyance to a receiving river system, resulted in greater quantities of pollutants delivered more efficiently to the river, while threats of flooding, erosion, destruction of streams, and deterioration of natural features went unabated or worsened. It is hoped that the ideas set forth in this management plan provide a blueprint for creative and successful resolution of the critical issues facing the Allen's Creek Watershed.

Appendix A. Potential Stakeholders

Allen’s Creek Watershed Group
Ann Arbor Public Schools
Ann Arbor Railroad
Ann Arbor Transportation Authority
Army Corp of Engineers
Building Department, City of Ann Arbor
Chamber of Commerce
City Council, City of Ann Arbor
Conrail
DDA Citizen's Advisory Council, City of Ann Arbor
Dover-Parkside Neighborhood Association
Downtown Development Authority, City of Ann Arbor
Fairglen Commons Neighborhood Association
Federal Emergency Management Agency
Flooded residents and businesses
Eberwhite Woods Committee, Ann Arbor Public Schools
Environmental Commission, City of Ann Arbor
Huron River Watershed Council
Liberty Glendale Neighborhood Group
Mayor's Office, City of Ann Arbor
Michigan Department of Environmental Quality
Michigan Department of Natural Resources
Michigan Department of Transportation
Michigan State Bureau of Construction Codes
Murray-Mulholland Residents Association
National Park Service
Neighborhood groups
North Central Neighborhood Association
Old West Side Association
Old West Side Garden Club
Parks & Recreation Department, City of Ann Arbor
Parkside Commons Condominium Association
Planning Commission, City of Ann Arbor
Planning Department, City of Ann Arbor
Residents along the creek and ravines
Residents and businesses within the floodplain and floodway
Transportation Department, City of Ann Arbor
U.S. Environmental Protection Agency
University of Michigan
Upstream businesses such as the West Stadium Business and Professional Association
Washtenaw County Drain Commissioner
Water Utilities Department, City of Ann Arbor
West Park Neighborhood Association

Appendix B. 1994 Creekshed Survey Results[20]

1. Has any of the following occurred in your area: basement flooding/ street flooding/ backyard flooding/ trash and debris in ditches/ erosion?

Major Problems	Minor Problems	No Problems	Don't Know
136	301	1,523	284

2. Has rainfall or storm water entered your home or business in the past?

No	Floor Drains	Bathtub, Toilet, or Sink	Windows/ Window Wells	Floors or Walls	Other
318	51	6	32	95	36

3. Has flooding occurred around your home or property?

No	Yard Flooding	Damage to Lawn/ Trees	Damages to Fences/ Buildings	Erosion of Ditches	Other
350	75	15	11	13	29

4. Has flooding occurred in a street near your home?

No	Yes
414	103

5. How many times has flooding occurred at your location during the past 5 years?

Never	Once	Two Times	Three Times	Four Times	Five or More
307	25	24	20	14	68

The city can provide copies of the survey and results through the City of Ann Arbor Water Utilities Office

Appendix C. Partial Summary of Relevant Government Regulations

A. Federal Regulations

1. National Flood Insurance Act of 1968 modified by Acts in 1973 and 1994

This is the basis for the National Flood Insurance Program (NFIP). It enables property owners in participating communities to purchase federally backed insurance protection against losses from flooding. The participating community must adopt and enforce a floodplain management ordinance / resolution to reduce future flood risk to new construction in floodplains identified on Flood Insurance Rate Maps. Under the NFIP Community Rating System, property owners with flood insurance pay lower premiums if the city receives a high score by implementing stringent floodplain management measures.

2. BOCA National Building Code

The National Building Code contains requirements for flood-resistant construction in Section 3107.0, which is referenced in the city's Floodplain Management Resolution, and a section on an appeals process and variance standards in section 121.0.

B. State of Michigan Regulations

1. Water Resources Protection Act, Part 31 of PA 451 of 1994 and Administrative Rules R 323.1311-1316

Floodplain Regulatory Authority found in these regulations applies to all types of construction (residential and non-residential). These regulations prohibit residential occupation of the floodway and other encroachments in the floodway if they may cause "harmful interference" (that is, an increased stage or change in direction of flow of a river or stream that causes or is likely to cause damage to property, a threat to life, a threat of personal injury, or pollution, impairment, or destruction of water or other natural resources).

2. Subdivision Control Act – PA 288 of 1967

This act requires that, during the platting process, no buildable lot may be created in a floodplain on land below the 100-year floodplain level

Ann Arbor Floodplain Management Resolution adopted November 1991 (originally adopted June 1974). This resolution is modeled on FEMA documents, and represents the minimum standards necessary to participate in the National Flood Insurance Program. It adopts the Flood Insurance Rate Maps dated January 2, 1992 and commits the city to enforcing the Flood Resistant Construction sections of the BOCA Code.

C. City of Ann Arbor Regulations

1. Chapter 57: Subdivision and Land Use Control, Section 5:127(1)(c)

This ordinance requires projects to be planned and constructed so as to prevent net loss of flood storage capacity due to floodplain mitigation. It provides protection priorities for floodplain activity by categorizing floodplains into high, mid-level, and low priorities, based on existing disturbances in the floodplain. The ordinance also includes Guidelines for the Protection and Mitigation of Natural Features in the section on Land Development Regulations.

2. Chapter 63:

Recent changes (2000) to the Ann Arbor City Ordinance Chapter 63 specify on-site regulations for water runoff in alignment with the County Drain Commissioner's Office Rules and in some cases goes beyond them.

D. Regional Regulations

In a recently published report[21], the U.S. Environmental Protection Agency has given a March 2003 deadline to area cities and townships for watershed cleanup.

The area includes Lansing, East Lansing and seven townships.

The nine municipalities have joined forces with the Tri-County Regional Planning Commission to form the Regional Stormwater Committee.

"During certain times of the year you are not allowed to touch the water in the Red Cedar (River)," committee chairman, Roger Buell, told the Lansing State Journal. "We intend to improve the quality of the water so it can be swimmable and fishable."

The committee must meet six requirements set by the EPA, including public education, controlling illicit discharge of septic tanks and monitoring construction site runoff.

Buell said the committee will develop a watershed management strategy. After determining a cost and getting EPA approval, the committee will seek state and federal grants to fund the project, said Jon Coleman, Tri-County Regional Planning Commission executive director.

The Red Cedar and Grand rivers are on Michigan's Impaired Water Bodies list. The list shows what bodies of water aren't meeting standards.

Appendix D. Education Program to Reduce Fertilizer Use

Allen's Creek delivers the highest concentration of phosphorus to the Huron River of any tributary stream in the middle Huron area. One of the principle reasons for the high level of phosphorus in residential stormwater is excessive application of lawn fertilizers.

The most effective solution to the problem of fertilizer-based phosphorus inputs would be limiting lawn fertilization. As advocated by the Huron River Watershed Council's Information and Education campaign, clippings from grass that is mowed high can be an excellent source of natural nutrients for a lawn. Also, lawn conversions from turf to native plant species eliminate the need for fertilizer altogether. The Allen's Creek Watershed Plan advocates the continuation of educational campaigns to familiarize residents with options for fertilizer use reduction. If voluntary effort should fall short, the community could discuss the feasibility of other approaches to reduce fertilizer use.

If the community supports continued fertilizer use, controlling excessive use by promoting lower cost alternatives to phosphorous can be explored. The key is to provide a less expensive and more environmentally sound lawn fertilizer and to inform the public about how applying less fertilizer can get the same or better results.

The Huron River Watershed Council is working with Michigan State University Cooperative Extension to encourage county residents to test their soil before applying fertilizer. This initiative aims to help people apply the appropriate type and amount of fertilizer to their lawns, and thereby reduce fertilizer runoff to the Huron River. To promote this effort, a publicity campaign run during the months of March and April of 1999 encouraged residents to take samples of soil to local fertilizer stores. Each soil test cost $15. The results were sent within two weeks. Participating stores stocked the fertilizers recommended by the soil experts. This program could ultimately reduce the costs of unnecessary fertilizer purchases and improve the quality of the Huron River. Increasing local publicity, establishing the program as an annual event, distributing information tip cards to residents each spring and issuing tip cards to all new residents in the area could enhance the program. In the future this program could be linked with community activities – for example, youth organizations and school clubs could collect soil samples.

Specific options for an education plan to reduce fertilizer use include:

- City of Ann Arbor sponsorship of an annual spring campaign to encourage residents to have their soil tested
- Identification and reduction of impediments to having soil tested (e.g., because the cost of sample testing was suggested as a barrier to soil testing, it would be useful to conduct a follow-up analysis with people who used the program this year to see how much money they saved by using the soil-testing program and how this changed their attitudes; next year's ads could then feature information on residents who used the program and have a good lawn with less cost)
- Encourage businesses and institutions to lead the way by getting their soil tested as one element of the Community Partners for Clean Streams program, and establish a public recognition program for their participation
- Establish awards for businesses using the least fertilizer
- Work with lawn care companies in the area to market creek-friendly fertilization packages (involving county extension agents in this effort)
- Create awards for the most environmentally responsible lawn care company
- Create awards for the most creek-friendly front yard

- Advertise and promote the availability of slow-release fertilizers both in stores and elsewhere
- Use “Issues of the Environment” and other local radio shows to promote soil testing
- Promote soil testing in the Ann Arbor News, the Observer, Agenda, and other community publications
- Provide a pamphlet on Allen’s Creek and creek-friendly homeowner stewardship with the initial tax bill sent to new residents

Appendix E. Potential Sites for Stormwater Detention

A preliminary examination of sites suggests the following locations might be candidates for stormwater detention / retention facilities:

City offices may obtain easements for retention sites on private properties with approval of council and if the purchase price is not prohibitive.

Main Stem
- Ann Arbor Railroad side yard north of Hoover
- Pioneer High School parking lot

Eberwhite Branch
- Parking lot in the center of the block bounded by Liberty, Third, and Murray Streets at the end of Krouse St. off Third.

Murray-Mulholland Branch
- 2060 W. Liberty Street
- Virginia Park
- Slausen School grounds

West Park/Miller Branch
- West Park
- Fox Village Center parking lot
- Veterans Park

Appendix F. Green Roof Systems

One example of an effective alternative to impervious roofs is the green roof system, of which James Patchett, the founder of the Conservation Design Forum in Elmhurst, Illinois writes:

> "...to enclose stormwater in a pipe, and convey it away from the site as quickly and efficiently as the law allows, is to fail at every level. Water should be collected, experienced for its beauty and function, cleansed, recycled, and absorbed on-site unless conditions dictate that it should be dispensed elsewhere. [Such] projects are characterized by surface water drainage systems artistically incorporated into the site in a variety of ways that communicate the beauty and function of water at every sensory level. Building and landscape functions are completely integrated through the use of green roof systems, coupled with internal and external collection, cleansing and recycling systems that, in turn, provide water for irrigation, gray water, and climate control. This combination of measures is designed to significantly reduce or outright eliminate the off-site discharge of stormwater runoff.[22]
>
> Research has indicated that even very simple green roof systems, composed of a 3 to 4 inch soil layer over a permeable sub-grade, and planted with a basic mixture of sedums, often in combination with a few grasses and wildflowers, can effectively absorb and evapo-transpirate 70 to 80 percent of the total precipitation that falls on the roof. Imagine the runoff reduction levels that could be achieved, particularly in urban areas that contain literally hundreds of acres of rooftop. A 70 to 80 percent absorption rate in the Chicago area, for instance, would result in the reduction of a minimum of 700,000 to 800,000 gallons of surface water runoff per acre of green rooftop per year. This is water that could be captured, easily cleansed, and reutilized on-site.[23]

In another contribution to the evolving technique of green roof systems, the architect William McDonough, who delivered the first Sustainable Development lecture at the University of Michigan during the latter's 1999 series, described a polymer he and his business partner had developed for a roof shingle that would absorb water during a rainfall and expand like a sponge. Patchett and McDonough have teamed up on development and redevelopment projects that emphasize minimal/zero stormwater runoff, including the Coffee Creek Center project in Chesterton, Indiana and a green roof retrofit of Chicago's City Hall.

It is reasonable to anticipate the construction of multi-story buildings that would either have zero stormwater runoff or use stormwater as a design amenity. For example, rainfall on the rooftop and sides of a multi-story building could be captured in a tank in the basement, and then pumped during dry periods up to street level through decorative fountains along the building's facade. The water would then either recycle back into the tank, or pass from the fountains into the storm drain system.

Appendix G. Porous Pavement for Parking Lots, Bike Lanes, Bikeways, Sidewalks and Roadways

Porous pavement allows stormwater runoff to infiltrate the pavement layer and enter the underlying soil. This provides for a high degree of soluble and fine particulate pollutant removal, groundwater recharge, and low flow augmentation and stream bank erosion control. Porous pavement is feasible on sites with gentle slopes, permeable soils and relatively deep water table and bedrock levels.

Alternatives to conventional asphalt that utilize a variety of porous media, often supported by a soil matrix, structural matrix, concrete grid, or modular pavement, allow water to percolate though to a sub-base for gradual infiltration.

Porous pavement can reduce long term paving costs, greatly help recharge ground water, help clean roadway polluted stormwater and reduce stormwater management constructions and long-term roadway and stormwater systems maintenance costs. The development of natural microbiological action in the pavement, shortly after installation, has been shown to provide significant natural detoxification of roadway pollution before entering the soil matrix.

Additionally uses of porous pavement have been used to significantly reduce urban road noise. Some projects are underway to install this product specifically for this purpose.

The City of Ann Arbor and the University of Michigan could begin incorporating the use of porous pavement in an effort to cut the substantial cost of road, parking lot, sidewalk, bike lane and bikeway construction projects and the commensurate reduction of considerable stormwater pollution and related stormwater management systems expenses. When calculations take into account all the obvious costs, including the true environmental cost, porous pavement systems have the potential to deliver substantial savings over time.

Wisconsin DNR Nonpoint Source Program Redesign Initiative - Draft Report September 1999. "The use of porous pavement is recommended."

The United States Air Force (USAF) construction specifications state in part: 'The USAF has implemented a variety of energy saving and pollution prevention strategies in the planning, design and construction of many facilities. By addressing these issues simultaneously the USAF will gain the synergy of realizing each of these goals contributing to the whole."

It goes on to state: "Consider pervious paving systems as an alternative to impervious systems; e. g., porous asphalt or concrete (constructed with "open-graded" aggregate lacking fine particles) instead of traditional asphalt. Reserve impervious pavement use for special situations such as swelling soils, highly plastic soils, or steep slopes."

US Federal Highway Administration.- Transportation Research Board; Nevada Department of Transportation; American Association of State Highway and Transportation Officials; World Road Association--PIARC CONFERENCE PROCEEDINGS 16, 1997: "In 1986, porous asphalt (drain asphalt or open-graded asphalt) was introduced in the Netherlands. By 1997, approximately 40% of all highways in the Netherlands had been paved with this open asphalt."

New Hampshire Department of Environmental Services, Nonpoint Source Program March 1998 reports: "Concern over the impacts of increased runoff from urbanizing areas has increased the availability of porous asphalt pavement. Porous pavement is similar to conventional asphalt in durability, but has a lower percentage of fine particles, allowing water to soak through."

The Southface-Journal of Sustainable Building • Volume 1, 1999 describes Bruce Ferguson's, a professor at the University of Georgia's School of Environmental Design, report relating to the structural properties of porous pavements and their possible applications:

"Because porous pavements allow rainwater to seep into the ground through pavement, the amount of stormwater runoff is reduced and water quality is improved. Porous pavements can be made of concrete, asphalt, open-celled stones, and gravel, that are mixed in a manner that creates an open cell structure allowing water and air to pass through.

"Unlike traditional concrete or asphalt, porous pavements typically provide a void content of 15-25%, offering improved filtration and an enormous amount of surface area to catch oils and chemical pollutants. The bacteria living in these spaces break down pollutants preventing much of the polluted runoff that normally occurs with traditional pavements. Parking lots, in particular, hold a tremendous potential for this material because of the amount of oil and other hydrocarbon liquids that seep from parked cars.

"Concerns about clogging up porous pavements can be “designed out”, according to Ferguson, by reducing erosion and sediment runoff through strategic design and water retaining ground cover.

"Although the rate of water filtration of porous pavements usually drops from an initial high of 160 inches of water per hour to a constant rate of **16 inches of water per hour,** this is still far above most conceivable rain events and highly effective in controlling stormwater drainage.

"There is also a broader urban application for this building material. The strength and durability of porous pavement appears to be equal to traditional materials. There are several examples of parking lots built more than twenty years ago with porous pavement that are still structurally sound and in use. Porous pavement is also less susceptible to freeze-thaw cracking. The material's ability to retain stormwater while improving water quality makes this material a very exciting example of green or sustainable building practice.

"Ferguson also advocates a new mind set when designing stormwater management systems. Rather than designing a system for huge storm events that may occur only once a century, water management planners should consider the smaller, more frequent rain intervals. Atlanta, for example, receives significantly more than half its annual rainfall from precipitation events of less than an inch. “The ecosystem lives and dies on daily events”, Ferguson says. A stormwater system incorporating porous pavement will be much more effective in reducing runoff and increasing the amount of filtered groundwater."

Washington Aggregates and Concrete Association (WACA) in it's 1999 'Building with Concrete and WACA Awards' This award to a porous pavement installation company states in part: "According to the concrete industry, the potential benefits for the use of "no fines" concrete fits well with the direction public works departments and developers are considering to meet the new standards for stormwater management. The immediate benefits of using "no fines" concrete result in no water leaving the site, eliminates the need for stormwater collection and detention systems, and increases the pervious to impervious ratio of a property. The multiple layer pavement and drainage system will naturally provide water retention and will essentially mimic the drainage and filtration action of naturally unpaved surfaces.

"No fines" or "Portland cement pervious pavement" is acknowledged and suggested as a best management practice in the Puget Sound Stormwater Management Manual.

EPA Office of Wetlands, Oceans & Watersheds Technical Note 21, Thomas Cahill, Cahill Associates:

“Contrary to prevailing wisdom, porous pavement/underground recharge bed BMP applications can be developed successfully. The quandary is illustrated vividly by porous pavement, a technique proposed over twenty years ago. After numerous unsuccessful installations, use of porous pavement is routinely rejected by most engineers, designers, and stormwater program developers.

Contrary to prevailing wisdom, however, porous pavement/underground recharge bed BMP applications can be developed successfully. Cahill Associates (CA), a suburban Philadelphia environmental engineering firm, has been designing and constructing porous pavement/recharge bed installations in Middle Atlantic State locations for over 12 years. Their porous pavement installations serve a range of building parking needs and customers include office centers, fast food restaurants, libraries, and condominiums. Areas covered range from 3,000 to 147,000 square feet. Experience has shown that most porous pavement failures occur because of a lack of erosion/sediment control during construction. In many instances, contractors, unfamiliar with what they were doing and why they were doing it, allowed substantial quantities of sediment to erode onto the pavement surface after installation.”

The Natural Resources Defense Council 1999 Report: "Stormwater Strategies-Community Responses to Runoff", This 11 chapter bound publication and internet published report states in part: "Porous asphalt and concrete differ from regular asphalt and concrete because fine materials are not added to fill in the gaps between the coarser aggregate in the pavement material, so that myriad small holes allow water to infiltrate. Porous asphalt and concrete are recommended for appropriate locations to recharge groundwater, reduce stormwater management costs and improve stormwater quality."

Timothy Randhir, Assistant Professor, Department of Natural Resources Conservation, Holdsworth Natural Resources Center University of Massachusetts, Amherst, also reports: "Open-graded (10% volume of voids in asphalt concrete) asphalt concrete was found to exhibit superior physical characteristics compared to conventional paving methods. Porous pavements allow for detention storage, increase aquifer recharge, improve water quality by reducing shock loading, alleviate flash flooding, and preserve natural drainage patterns."

Porous pavement in a cold climate thesis 1999-04-20 **Sweden** ISSN 1402-1757 / ISRN LTU-LIC--99/21--SE / NR 1999:21
State in part: “In-situ measurements of ground temperature, frost heave, groundwater levels, and runoff was performed. The draining function of the porous asphalt at different ambient air temperatures in the range -10 °C to +20°C was investigated in the laboratory. It was found that porous pavements have a potential to reduce meltwater runoff, avoid excessive water on the road surface during the snowmelt period, and accomplish groundwater recharge by local disposal of stormwater. The porous pavement was more resistant to freezing and frost heave than a comparable impermeable pavement. The full-scale porous pavement construction was not damaged by irregular frost heave. Thawing of porous pavement was a rapid process, which was explained by meltwater infiltration during the beginning of the snowmelt period.”

Appendix H. Exploring the Option of Surface Water Flows - Daylighting

Well over 95% of Allen's Creek have been enclosed in storm drains. As the community continues to implement ameliorative watershed management policies, the possibility will arise of bringing significant stretches of Allen's Creek back into the daylight.

In the upper stretches of the watershed, this could include removing the storm drain pipes altogether and restoring the natural creek channel. This process might occur in areas such as West Park or the ravine running east from Veteran's Park, for example.

Regarding the main branch of the storm drain, say from W. William St. down to the Huron River, restoring the original creek channel would pose more of a challenge. Current very high flow rates and volumes during flooding events would likely create a significant hazard and would need to be mitigated. Also, part of the main branch of the storm drain runs directly under buildings, which would need to be removed; this would be both costly and politically controversial.

In some areas there is an alternative: the creation of a parallel, "designed" open channel running through the lower Allen's Creek valley. The storm drain would remain in place to handle storm and flood events, while the open channel above ground would contain a continuously running stream of high-quality surface runoff water.

This concept draws inspiration from the work of James Patchett and Herbert Dreiseitl. As described by Patchett in "**Water Conservation**," Volume III, No. 1, Spring 1999, the journal of the American Society of Landscape Architects, surface water flows of stormwater can be designed both as aesthetic amenity and as a reminder to people in the community of the existence of a watershed and its ecology. The concepts they have advanced are suitable for an urban watershed such as Allen's Creek.

In “Daylighting: New Life For Buried Streams” Written by Richard Pinkham Rocky Mount Mountain Institute[24], a US EPA funded report, documents in detail 18 projects that have day-lighted over 14,000 feet of waterways in the continental United States. Another five completed projects in the United States are listed and it describes or lists another 23 projects that are in various stages of consideration.

As Richard Pinkham of the RMI describes it “[t]he term ***daylighting*** describes projects that deliberately expose some or all of the flow of a previously covered river, creek, or stormwater drainage. Daylighting projects liberate waterways that were buried in culverts or pipes, covered by decks, or otherwise removed from view. Daylighting re-establishes a waterway in its old channel where feasible, or in a new channel threaded between the buildings, streets, parking lots, and playing fields now present on the land. Some daylighting projects recreate wetlands, ponds, or estuaries.”

In just one example sited, the city of Kalamazoo daylighted a five-block section of Arcadia Creek in downtown as part of a multi-year, multi-million-dollar redevelopment project completed in 1995. From 1989 to 1992, the Downtown Development Authority and its consultants completed engineering studies, did design work, secured development agreements, and funded the project. Construction took place from 1989 to 1995.

The combined stream, channel, stormwater pond, and double culvert provide Kalamazoo with protection from a **500-year flood**. Authorities have now redrawn local floodplain maps. Downtown properties **no longer pay flood insurance.**

The flood-protection benefit and amenity value of the creek combine with the overall redevelopment effort to boost the attractiveness of Kalamazoo's downtown for private investment. Ken Nacci, director of the Downtown Development Authority, puts it succinctly: "What we have is much better than what we had." Public-sector investments of $18 million for the entire redevelopment project have leveraged more than **$200 million** in private development, including a new museum, a bank headquarters, and other institutions and businesses. Property tax revenues to the city from the redevelopment zone have increased from $60,000 to **$400,000** annually. Activities at the new festival site by the stormwater pond generate an estimated **$12 million annually** in sales and payroll for local businesses. Nacci also notes: "… and we still have some available properties" that could be added to further increase the tax roles.

The Downtown Development Authority issued bonds based on tax-increment financing; these bonds are now being repaid by property-tax revenues from the redevelopment zone.

In the recently published book "The Language of Landscape"[25], Anne Whiston Spirn, Professor at MIT, Boston Massachusetts, describes similar work in both Philadelphia, Pennsylvania and Boston, Massachusetts, where she helped design the plans that created a conversion of slums and abandoned areas in floodways and floodplains into green spaces and open creek areas with great success. Neighborhoods in these areas have also changed dramatically for the good in a few short years after completion of the projects.

She argues that these areas do not become slums because of the people who live in them but because of there inherent un-liveblity in the floodways and floodplains. Additional redevelopment of dilapidated structures and abandoned sites in the areas were rejected with her guidance and foresight.

Sprin writes about the Philadelphia project, "Rain now runs off rooftops, streets, and sidewalks into ponds in the parks, ponds that contain the water and slow its passage to the sewer, the treatment plant, and the river.

Mill Creek parks are now models of community development, environmental education, and water management, the first sewered, urban floodplain to be mapped in the United States, the first use of inner-city vacant land for stormwater detention to prevent combined sewer overflows, the pilot for many other projects in Philadelphia that saved millions of dollars."

Ann Arbor has great opportunities in these areas as well, similar to Boston, Philadelphia, Kalamazoo and other cities that worked hard to make the most of their natural resources and bring natural landscapes back to downtowns. It is clear these city's citizens and the environment have reaped much as a result.

Appendix I. Optional Site for Wetland Restoration

Wetland preservation and restoration should be undertaken in Allen’s Creek. An example of a potential wetland site for restoration is the parcel owned by the Ann Arbor Art Center on Felch Street. This site appears to have been at one time a floodplain wetland adjacent to Allen’s Creek. However, industrial use as an oil station with a cement and concrete oil storage platform built into the wetland led to the wetland’s degradation. The deteriorating platform remains. This wetland could be restored for water quality and quantity benefits, perhaps as part of the Allen’s Creek greenway. Another potential site is the wetland in West Park, southeast of the band shell, which appears much larger in an aerial photograph taken in 1948.

Appendix J.Greenway Development Options

An Allen's Creek greenway could start from the planned greenway along the Huron River and run through downtown Ann Arbor up to the University of Michigan athletic campus. Further, the greenway could potentially branch out along Allen's Creek up through Ann Arbor's west side, linking existing (and possibly new) parks along the creek route.

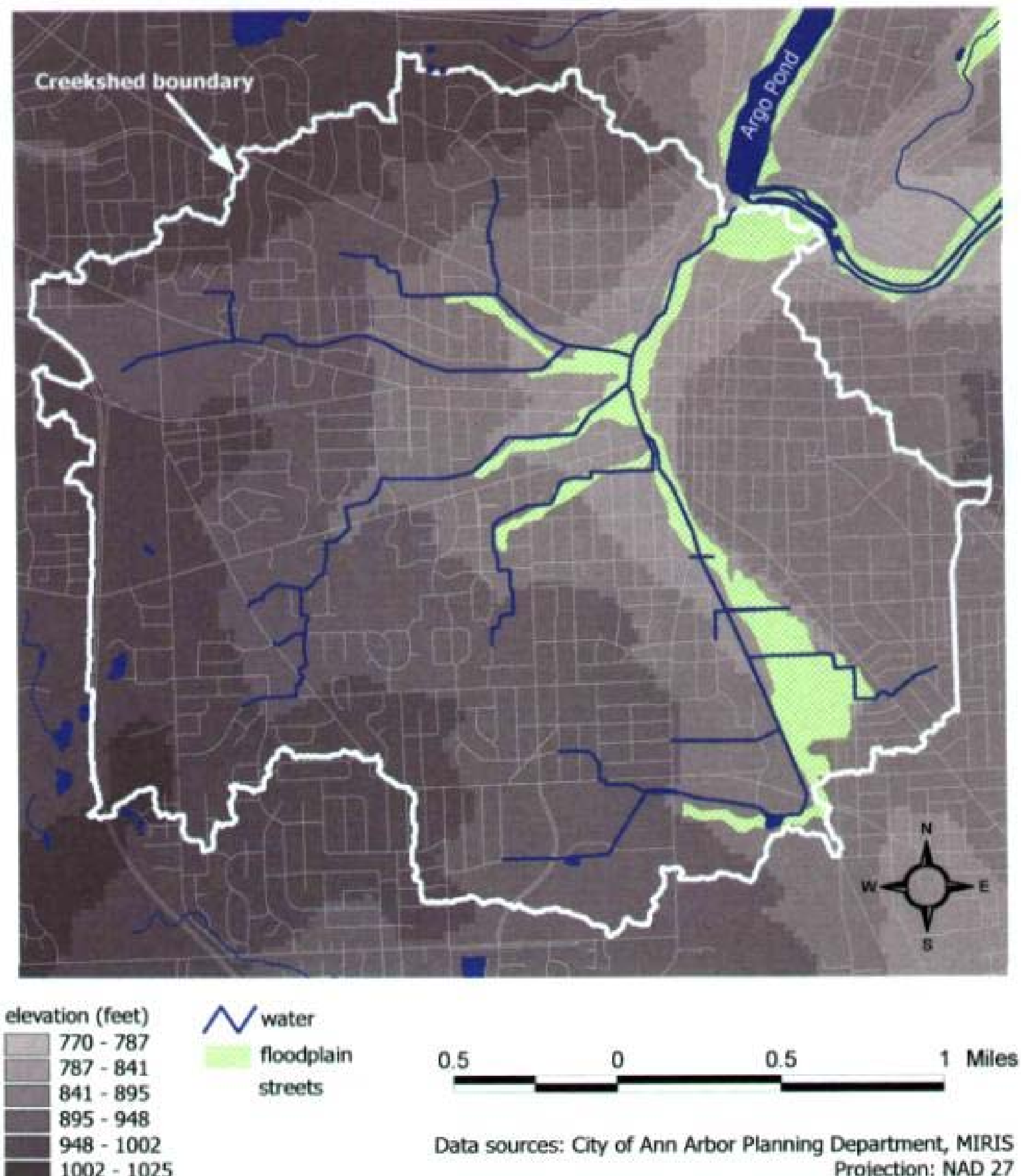
For example, a connected greenway along the West Park Branch could run from the main stem of Allen's Creek at the Ann Arbor Railroad, through West Park, up along ravines to Wildwood Park and then to Veteran's Park. Because the City of Ann Arbor is considering a detention pond for the triangular lot behind the Kmart in the Maple Village Shopping Center, this detention facility could be designed as a park as well and be linked to Veterans Park via the greenway path. Finally, the greenway could be extended to Evergreen Park on the far west side of the city.

Several issues emerge regarding the question of greenway development. For example, it would not be possible to link the parks along the upper branches with an uninterrupted green pathway. Part of the path would have to be along street and sidewalks. However, the path could be marked as part of the Allen's Creek greenway system, with decorative guideposts signifying that spot's location on a map of the watershed.

In the lower Allen's Creek watershed along the main stem of the creek from the University of Michigan golf course to the Huron River, a different set of considerations emerges. Here, much of the floodway is developed and includes significant historic residential neighborhoods. A greenway through these neighborhoods would be planned to provide homeowners in these neighborhoods with an adjacent amenity.

Appendix K. Allen's Creek Watershed Maps

Figure 1. Allen's Creekshed with elevation, streets, and floodplain



Data sources: City of Ann Arbor Planning Department, MIRIS
Projection: NAD 27
Map created by Huron River Watershed Council
August 2000

1.

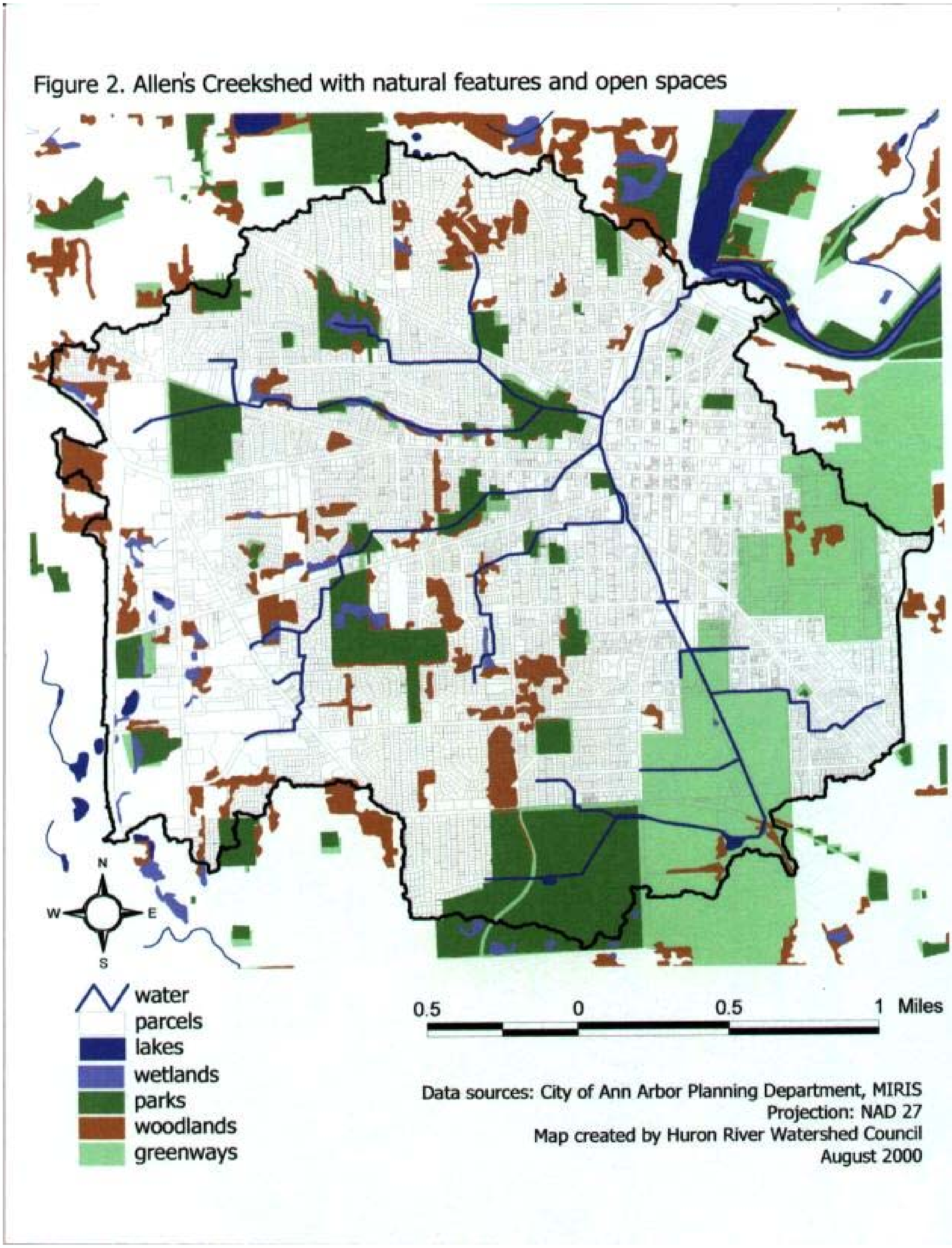
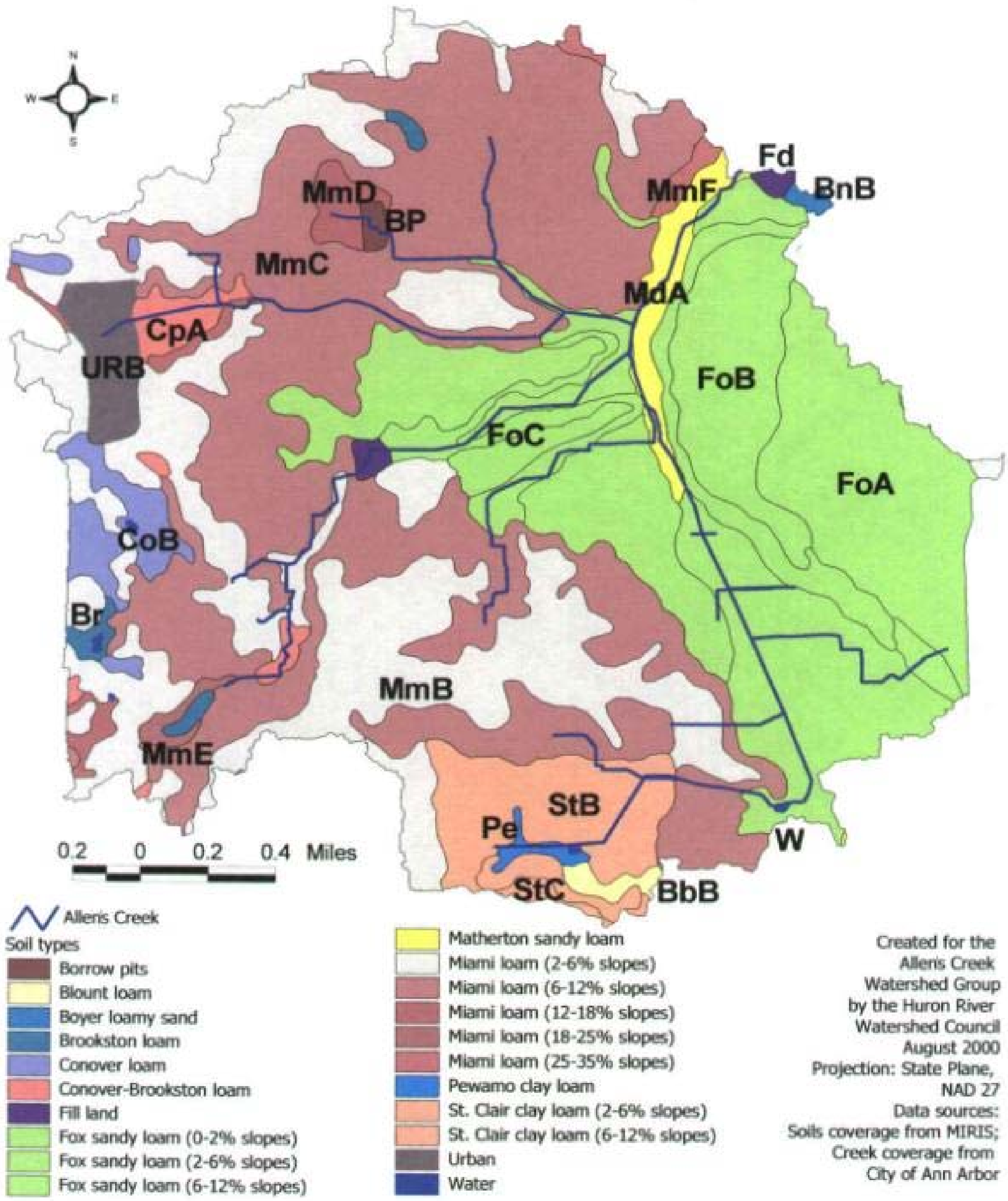


Figure 2. Allen's Creekshed with natural features and open spaces
N
W
E
S
water
parcels
lakes
wetlands
parks
woodlands
greenways
0.5
0
0.5
1 Miles
Data sources: City of Ann Arbor Planning Department, MIRIS
Projection: NAD 27
Map created by Huron River Watershed Council
August 2000

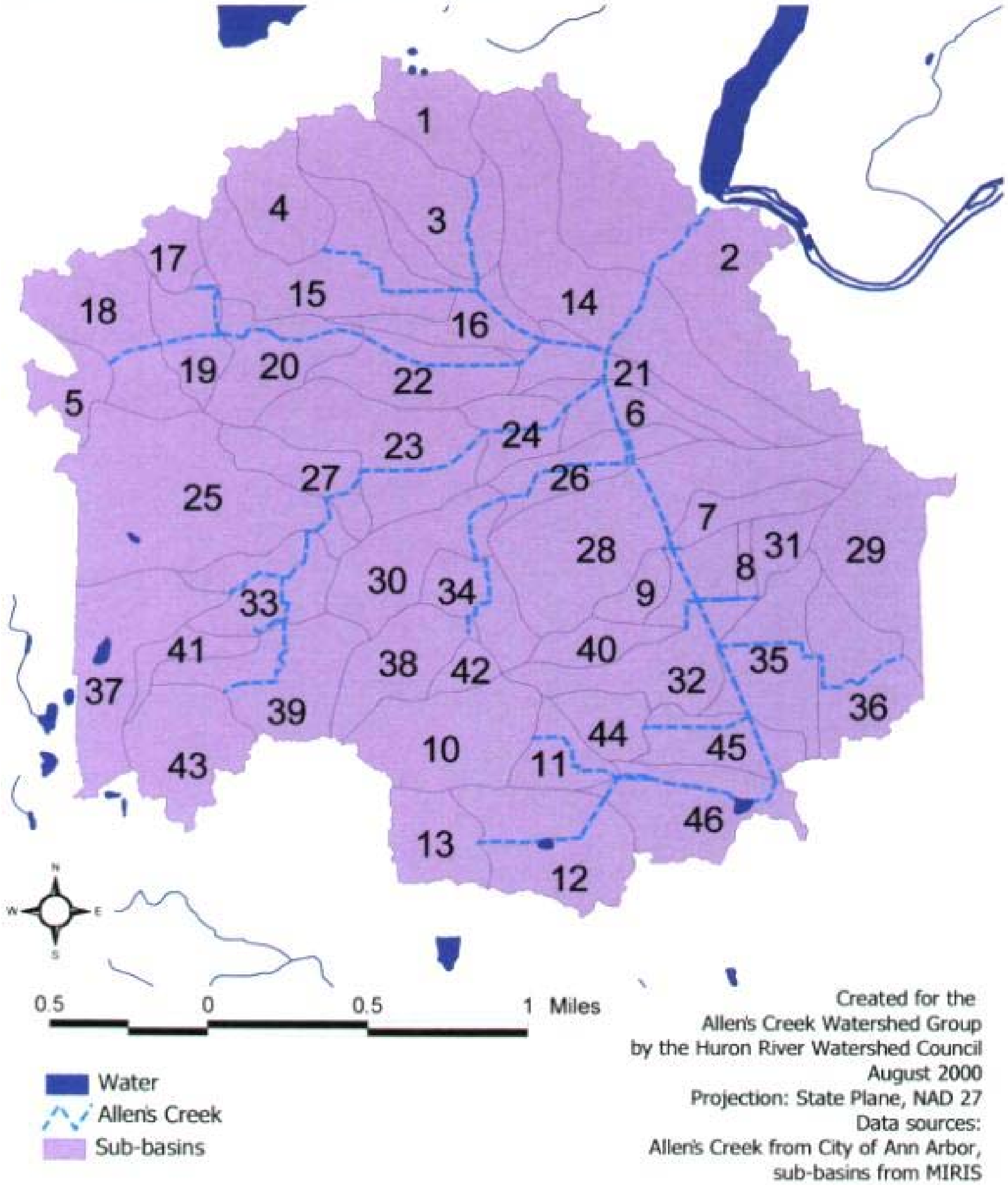
2.

Figure 3. Allen's Creekshed soils



3.

Figure 4. Allen's Creekshed with sub-basins



4.

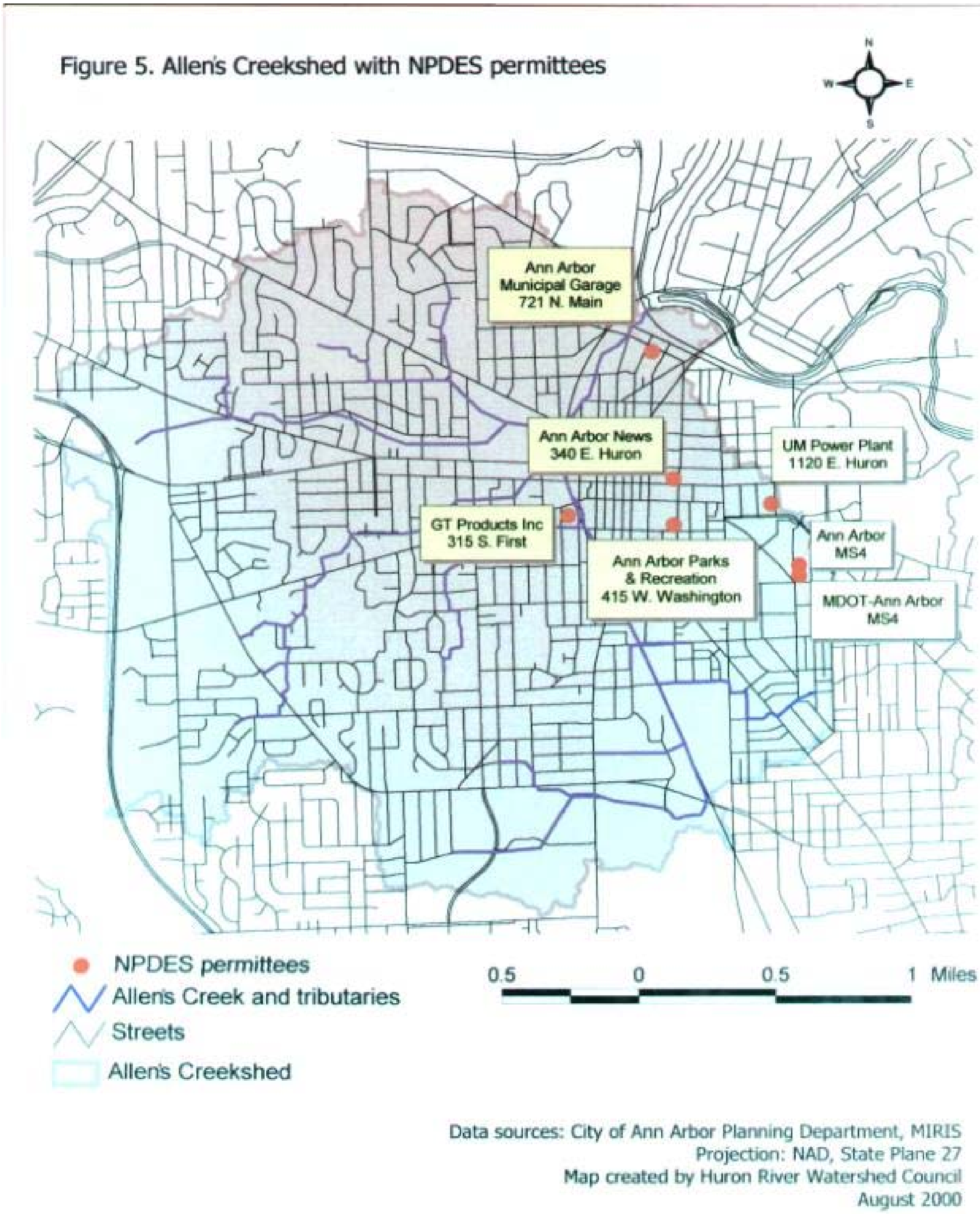
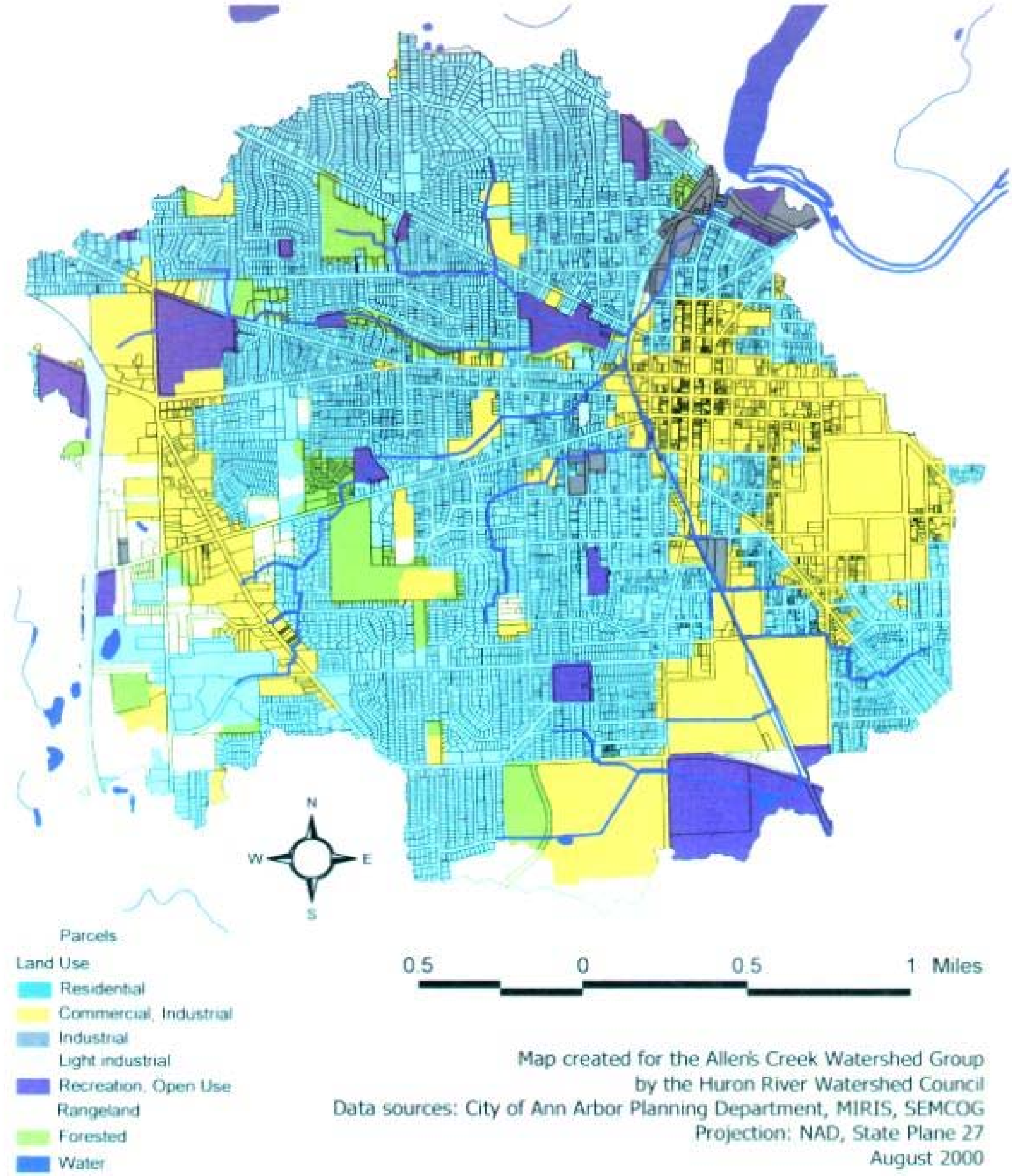


Figure 5. Allen's Creekshed with NPDES permittees
N
W
E
S
Ann Arbor Municipal Garage 721 N. Main
Ann Arbor News 340 E. Huron
UM Power Plant 1120 E. Huron
GT Products Inc 315 S. First
Ann Arbor MS4
Ann Arbor Parks & Recreation 415 W. Washington
MDOT-Ann Arbor MS4
NPDES permittees
Allen's Creek and tributaries
Streets
Allen's Creekshed
0.5
0
0.5
1 Miles
Data sources: City of Ann Arbor Planning Department, MIRIS
Projection: NAD, State Plane 27
Map created by Huron River Watershed Council
August 2000

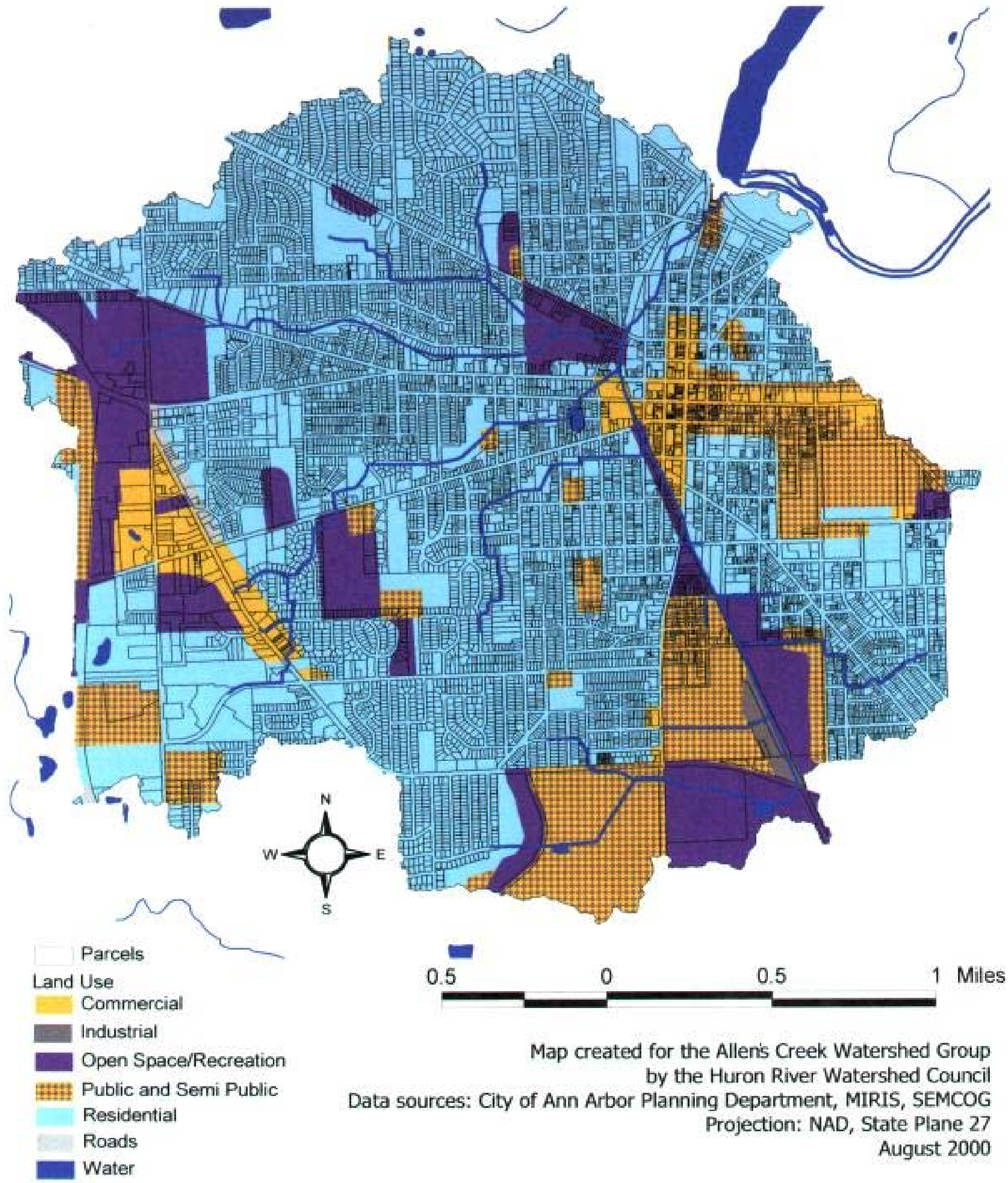
5.

Figure 6. Allen's Creekshed with 1995 land use



6.

Figure 7. Allen's Creekshed with future land use (per master plan)



7.

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[1] Also referred to as Allens Creek, Allen's Drain or Allens Drain.

[2] "Control of Nitrogen Export from Watersheds by Headwater Streams," Bruce J. Peterson, Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA. *Science*, Vol. 292, No. 5514, 6 Apr 2001, pp. 86-90.

[3] United States Center of Disease Control. Update: Pulmonary hemorrhage/hemosiderosis among infants -- Cleveland, Ohio, 1993-1996. *MMWR*. Vol. 46, No. 2, pp. 33-35, 1997; see also http://www.cdc.gov/epo/mmwr/preview/ mmwrhtml/00045680.htm.

[4] United States Environmental Protection Agency - Children's Health Initiative: Toxic Mold; Referenced January 2001at

http://www.epa.gov/appcdwww/crb/iemb/child.htm.

[5] "The Importance of Imperviousness," T. R. Schueler, *Watershed Protection Techniques* Vol. 1, No. 3, Fall 1994, pp. 100-111; "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator, " C. I Arnold and C. J. Gibbons, *J. Am. Planning Assn.* Vol. 62, No. 2, Spring 1996, pp. 243-258.

[6] Huron River Watershed Council, 2000.

[7] "The Causes of Urban Stormwater Pollution," in *Stormwater Strategies-Community Responses to Runoff*, The Natural Resources Defense Council, Chap. 2, 1999 (see also http:/www.nrdc.org)

[8] "Reducing Toxic Air Pollution in Lake Michigan," Delta Institute, 2001, www.delta-institute.org referenced May, 2001.

[9] "Allen Creek Drain Water Quality Survey and Status Report," the Offices of the Washtenaw County Health Department and Drain Commissioner

[10] "The Middle Huron Initiative - Phosphorous Reduction Strategy for the Middle Huron Watershed," A. Brenner and P. Rentschler, Huron River Watershed Council, 1996.

[11] "City of Ann Arbor, Michigan Storm Water Master Plan," Black & Veatch, Nov. 1997.

[12] 44 CFR Sec. 60.1(d)

[13] "City of Ann Arbor, Michigan Storm Water Master Plan," Black & Veatch, Nov. 1997.

[14] "City of Ann Arbor, Michigan Storm Water Master Plan," Black & Veatch, Nov. 1997.

[15] "City of Ann Arbor, Michigan Storm Water Master Plan," Black & Veatch, Nov. 1997.

[16] Midwestern Consulting, Ann Arbor MI, Design Report to the City of Ann Arbor - Liberty Glendale Storm Drainage Improvement Project, MCI Job # 96218 - December 2, 1996

[17] http://www.city.palo-alto.ca.us/earlywarning/creeklevels.html

[18] Cahill Associate's Dupont Project is one of over two dozen installations of porous pavement and innovative stormwater management systems; http://www.thcahill.com/english/projects/porousproj/dupont.htm (2000)

[19] "Daylighting: New Life For Buried Streams," by Richard Pinkham Rocky Mount Mountain Institute, Old Snowmass Colorado 2000

[20] "City of Ann Arbor, Michigan Storm Water Master Plan," Black & Veatch, Nov. 1997.

[21] Detroit Free Press, December 4, 2000

[22] Patchett, *op cit.*, p. 1.

[23] Patchett, James, "Letter from the Chair," Water Conservation, Volume III, Number 1, Spring 1999, p. 3.

[24] "Daylighting: New Life For Buried Streams," by Richard Pinkham Rocky Mount Mountain Institute (www.rmi.org), Old Snowmass Colorado, 2000, http://www.rmi.org/images/other/W-Daylighting.pdf

[25] "The Language of Landscape", Anne Whiston Spirn, Yale Unviersity Press, 1998; http://www.yale.edu/yup