REDESIGNING THE URBAN WATER CYCLE
A VISION FOR RIDGEDALE MALL 2030

ARCH 8567 : Building and Site Integration in Sustainable Design
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Determining The Urban Water Cycle Project
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Resilient Communities Project

UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

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WHAT IS RCP?

The Resilient Communities Project (RCP) is a direct response to the growing need to find sustainability solutions to pressing issues facing our communities. RCP does this by connecting the wide- ranging expertise of University of Minnesota faculty and students with communities in Minnesota.

Each academic year, RCP chooses one partner community through a competitive request-for- proposal process. Working with a broad range of city staff and stakeholders in the selected community, RCP helps to identify potential projects based on community-identified sustainability issues and needs. RCP then serves as a centralized "matchmaker," connecting the city's project needs with existing graduate and professional courses and independent graduate student projects at the U of MN. At the conclusion of the partnership, RCP can assist project partners to create a strategy to implement, evaluate, and monitor their ongoing sustainability efforts.

For communities, RCP provides access to hundreds of students and faculty members across a range of disciplines from architecture, planning, and engineering to business, environmental sciences, and the humanities. Expertise is available related to all aspects of sustainability (e.g. environmental health, economic opportunity, social equity, and community livability) and all stages of sustainability efforts (analysis, planning, design, implementation, and evaluation).

For students and faculty, RCP facilitates meaningful opportunities to gain experience in analyzing and advancing community sustainability. RCP offers faculty efficient access to community projects, and students benefit from real-world opportunities to apply their knowledge and training. They also bring energy, enthusiasm, and innovative approaches to address difficult, persistent problems.

ABOUT THE CITY OF MINNETONKA

The City of Minnetonka is located in Hennepin County just eight miles west of Minneapolis. A fully developed suburban community of 49,374 residents (2010 Census), Minnetonka is the 17th largest city in Minnesota. Minnetonka is proud of its reputation as a city that preserves its natural resources-residents can enjoy 49 community parks, more than 81 miles of maintained sidewalks and trails and more than 1,000 acres of public open space, as well as natural scenery that includes mature trees, wetlands and prairies. Minnetonka is a home-rule charter city, governed by a city council, with the mayor presiding over meetings.

While Minnetonka shares its name with the very popular Lake Minnetonka, the city of Minnetonka includes only one small bay of the lake Two other creeks travel through Minnetonka – Nine Mile Creek and Purgatory. Numerous small lakes, ponds and wetlands punctuate Minnetonka's landscape.

Minnetonka is a thriving center of commerce, with the headquarters of Cargill, United Health Group and Carlson Companies located within the city, as well as many other companies that together employ 46,000 people. Several major highways intersect Minnetonka, which makes Minnetonka an attractive location for employees and employers alike. Minnetonka is also home to Ridgedale Mall, one of the regional retail "dales."

PROJECT SUMMARY

The ARCH 8567 *Determining Urban Water Cycle Project* analyzed the urban water cycle on the site of the Ridgedale Mall in Minnetonka, Minnesota. The project considered all building and storm waters with a goal of creating a design that, 1) accommodates 90% of all storm water, and 2) addresses appropriate use and reuse of site water, while being beautiful, educational, and interactive.

SCOPE OF SITE DESIGN

The Primary, or Ridgedale Mall Site is bound by 394 to the north, and Ridgedale Drive to the East, West and South. The secondary, or Extended Site is the commercial area immediately surrounding Ridgedale Drive, south of 394, east of Crane lake, and north and west of the nearby residential areas (FIGURE 1.1).

The Primary Site, is dominated by the mall and its parking. Development in this site will be mostly infill, and will be of a more public or commercial nature. Development in the Extended Site will include infill and new development, with a greater mix of residential and commercial uses.

The total site is about 10.6 million SF, or roughly half the size of the Minneapolis Central Business District, for comparison.

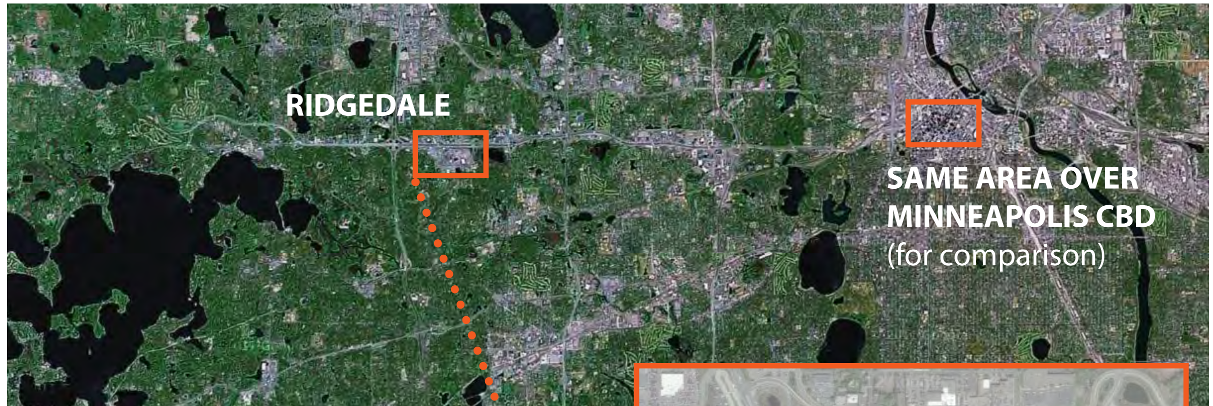
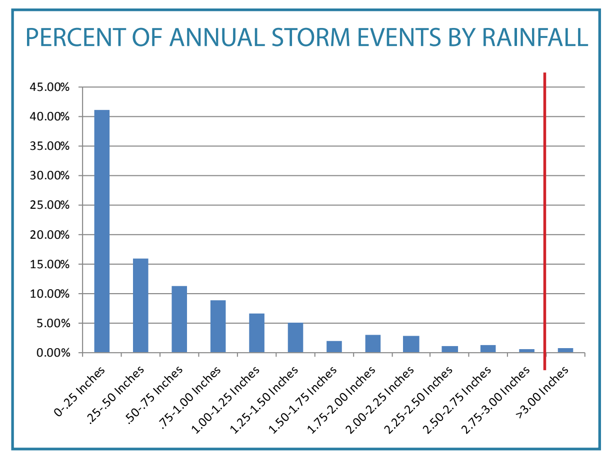


FIGURE 1.1: An aerial view of the 10.6 Million SF site, showing its context in the Twin Cities, and its impervious interruption in the surrounding area. Enlarged view of the site shows the subdivided "Primary" and "Extended" Site boundaries.

DESIGN GOALS

Proposed designs should accommodate 100% of a 2.8 inch storm event. If the design accommodates a 2.8 inch storm event, it will be able to accommodate over 90% of the annual on-site precipitation (FIGURE 1.2). This will decrease the annual runoff from the combined site from 13,876,991 gallons a year by over 90% and reduce the negative impacts of runoff on local water resources.

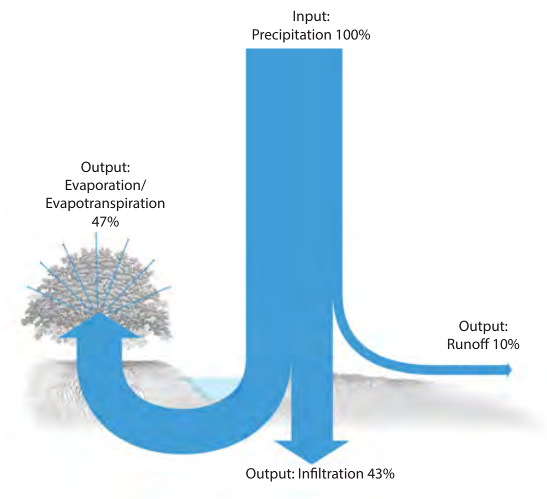
FIGURE 1.2 RIGHT: Percent of Annual Storm Events by Rainfall graph shows average rainfall amounts. Over 90% of area rainfall events are less than 2.8" rain events. A design that accommodates a 2.8" rain will accommodate over 90% of annual on-site precipitation.



IMPORTANCE OF PRE-SETTLEMENT SITE CONDITIONS

By understanding the water cycle under pre-settlement conditions--in particular, land use change by European settlers beginning in the mid-nineteenth century--we can better understand what the natural water cycle for the site looks like, and thereby determine what a repaired "urban" water cycle should look like. The goal is to create a design that reestablishes a 'normal' and healthy water cycle, including recharge rates to groundwater, evaporation and evapotranspiration rates.

BELOW: PRE-SETTLEMENT WATER CYCLE FLOW DIAGRAM & CHART



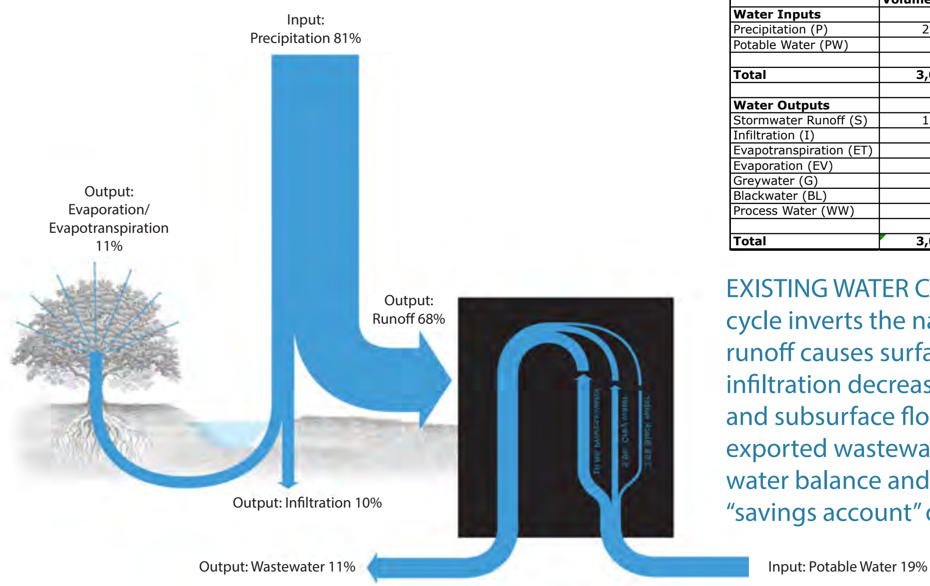
PRE-SETTLEMENT CONDITIONS			
	Volume (cu.ft.)	Volumee (gal)	Percentage
Water Inputs			
Precipitation (P)	2,495,327	18,664,370	100.00%
Water Outputs			
Stormwater Runoff (S)	249,524	1,866,437	10.00%
Infiltration (I)	1,069,387	7,999,015	42.86%
Evapotranspiration (ET)	588,163	4,399,459	23.57%
Evaporation (EV)	588,163	4,399,459	23.57%
Total	2,495,237	18,664,370	100.00%

PRE-SETTLEMENT WATER CYCLE: The pre-settlement water cycle is important to understand as a natural baseline for the site. This baseline helps to determine goals for a repaired water cycle that balances evaporation, evapotranspiration, infiltration, and runoff rates which impacts local and regional water resources.

IMPORTANCE OF A RESTORED WATER CYCLE

The water cycle on the site has an impact on regional water resources. Watersheds with increased impervious surfaces see degradation in streams, wetlands, ponds, aquifers and lakes throughout the water shed. When the natural hydrological cycle is interrupted, it has an impact on subsurface flows, which maintain normal stream flows and water levels. Decreased surface groundwater for plants to absorb increases the demand for irrigation. The hydrological cycle also impacts soil quality, deep groundwater recharge, habitat quality, and the cooling effect of evaporation and evapotranspiration, which counteracts the urban heat island effect.

BELOW: EXISTING WATER CYCLE FLOW DIAGRAM & CHART



EXISTING CONDITIONS			
	Volume (cu.ft.)	Volume (gal)	Percentage
Water Inputs			
Precipitation (P)	2,495,327	18,664,370	80.81%
Potable Water (PW)	592,520	4,432,053	19.19%
Total	**3,087,757**	**23,096,423**	**100.00%**
Water Outputs			
Stormwater Runoff (S)	1,855,084	13,876,991	60.08%
Infiltration (I)	312,261	2,335,874	10.11%
Evapotranspiration (ET)	163,946	1,225,601	5.31%
Evaporation (EV)	163,946	1,225,601	5.31%
Greywater (G)	181,496	1,357,684	5.88%
Blackwater (BL)	76,564	572,738	2.48%
Process Water (WW)	334,460	2,501,934	10.83%
Total	**3,087,757**	**23,096,423**	**100.00%**

EXISTING WATER CYCLE: The existing water cycle inverts the natural cycle. Increased runoff causes surface water pollution, low infiltration decrease groundwater recharge and subsurface flow. Imported potable and exported wastewater interrupts regional water balance and draws from nature's "savings account" of groundwater resources.

NEGATIVE CONSEQUENCES OF IMPERVIOUS SURFACES

Parking lots dominate the current site, creating a vehicular landscape that is inhospitable for people, and harmful to the environment. This environment is hazardous and threatening for pedestrians when there are no safe walking areas and people are exposed to the elements.

Stormwater that runs across impervious surfaces becomes polluted as it picks up contaminants that have collected on the surface. As it crosses the hard surface, its temperature is often raised, and its velocity increases. When the stormwater runoff is then collected in underground pipes and discharged immediately into ponds and streams, the warmed, polluted water causes bank erosion and contamination. Localized flash-flooding is also a concern in areas that are dominated by impervious surfaces.

RESPONDING TO IMPERVIOUS SURFACES

Collecting, treating, and infiltrating stormwater as close to the source as possible is key to preventing pollution of our water resources. By combining landscape and building strategies that collect, treat, and infiltrate storm water over a longer period of time, water pollution, bank erosion, habitat degradation, and flash flooding that are attributed to stormwater runoff from impervious surfaces can be avoided.

Impervious Surfaces Diagram Showing Primary Ridgedale Site and Surrounding Extended SIte Boundaries

7.2 MILLION SF IMPERVIOUS SURFACES

During a 1" rain event, the amount of stormwater runoff generated from the impervious surfaces on the site would be enough water to fill about 7 Olympic swimming pools

ABOVE : Diagram showing impervious surfaces in the Ridgedale site and surrounding areas. Dashed lines show the primary and extended site boundaries. Development within the Ridgedale site will be generally associated with the mall and civic functions. Development in the outer are will be a mixture of commercial and residential, and some significant changes have been proposed to land use and existing building stock.

Extensive impervious surfaces can lead to water pollution, habitat degradation, and flash-flooding. These negative impacts of impervious surfaces can be addressed by collecting runoff from impervious surfaces as close to the source as possible, and utilizing bioretention and bioremediation strategies to treat it on-site.

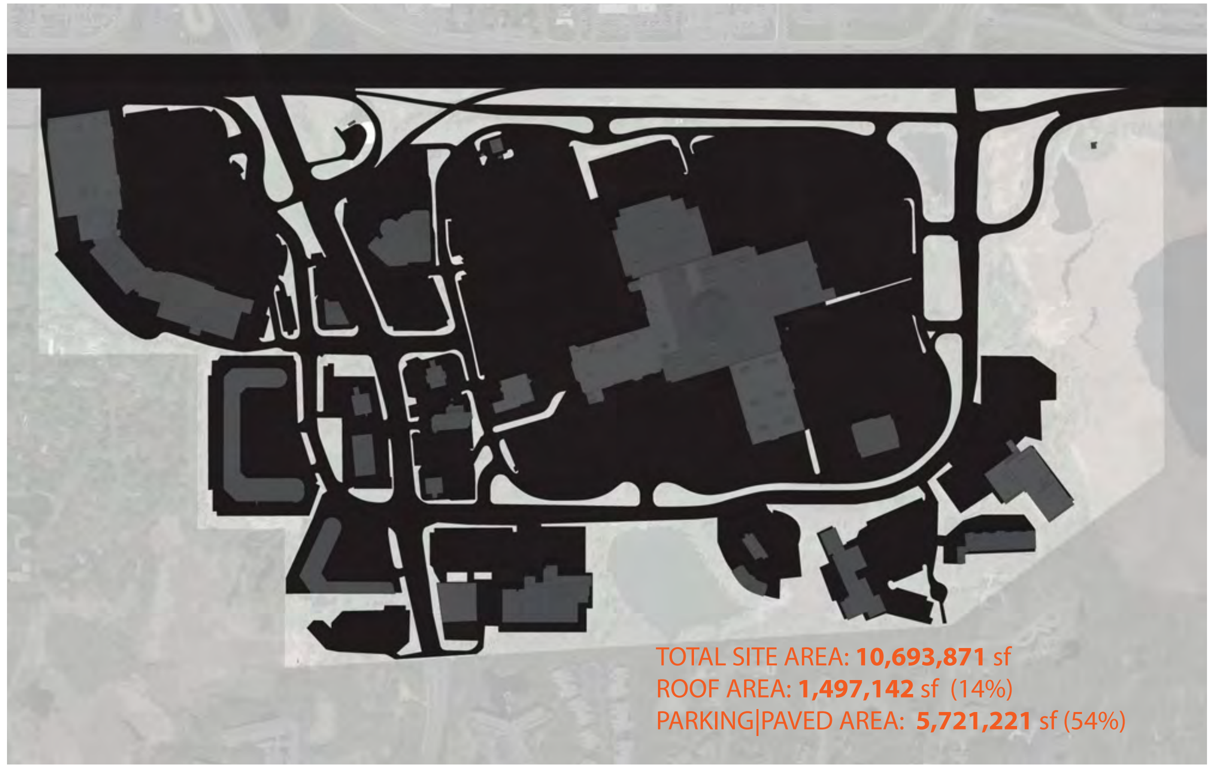
SUMMARY OF EXISTING IMPERVIOUS SURFACES

The existing site is overwhelmed by impervious surfaces which create runoff. Depending on the source of runoff--whether building rooftops, parking lots, or streets--pollution carried by the water and our ability to control it varies significantly.

Paved surfaces are the most critical for stormwater runoff. Driving and parking surfaces collect fluids and debris from vehicles. When stormwater runs across these surfaces, it collects the contaminants left behind by cars, is heated by the pavement, and becomes polluted. Runoff follows the grading of the hard surface on which it lands, collecting in low spots which can lead to flooding if the water cannot infiltrate.

Building rooftops typically have controlled drainage systems, so that runoff is channeled into gutters or downspouts. In addition, rooftops are generally cleaner than parking lots, so building runoff is not only easier to control, but less polluted. As rooftop space is not typically as highly in demand as parking space, converting rooftops to surfaces that will absorb the stormwater is also a more favorable option than converting parking lots into wetlands.

Summary Diagram Showing Impervious Rooftop and Paved Surfaces

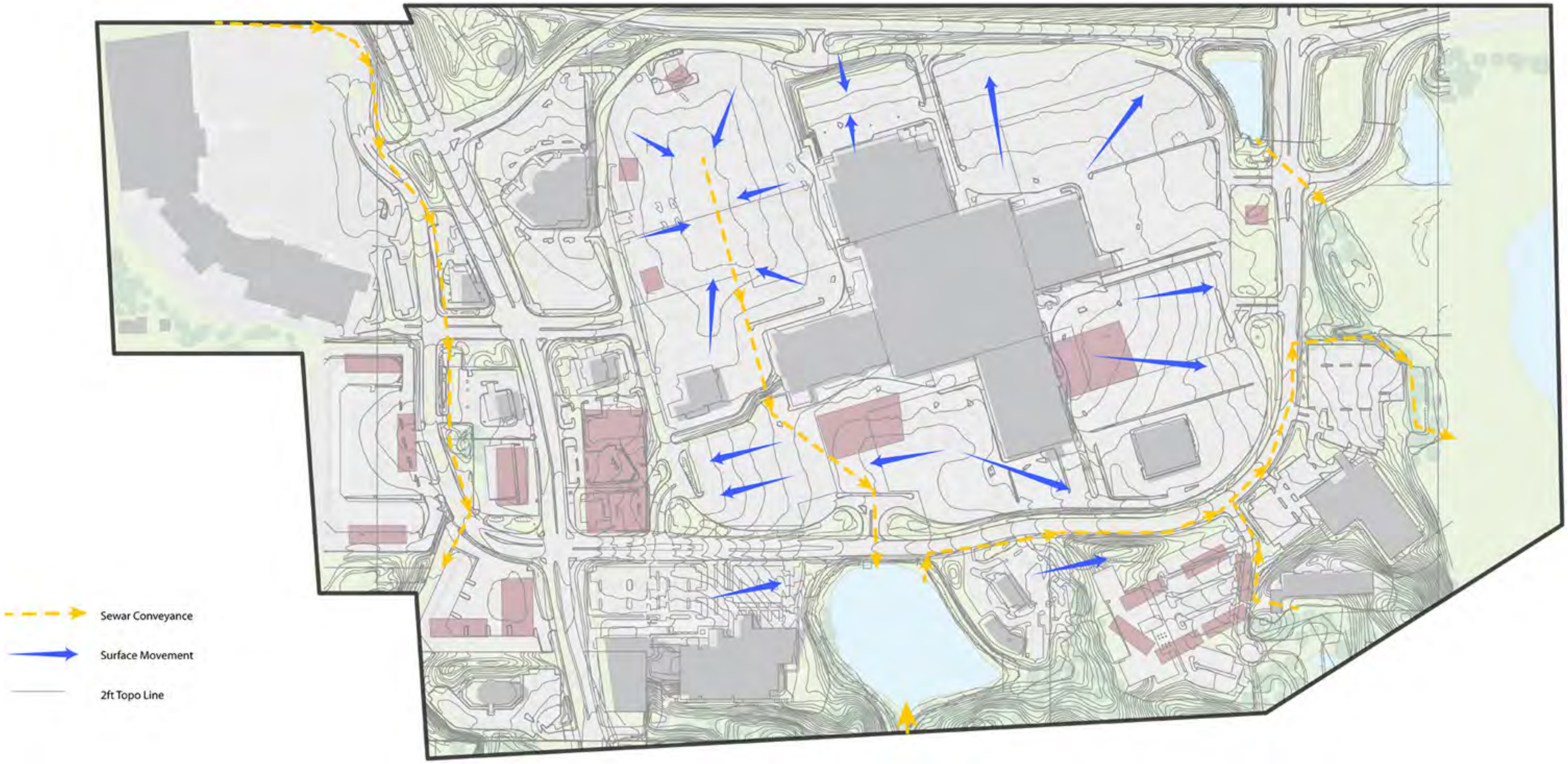


ABOVE : Impervious surfaces diagram. Parking lots and driving areas are shown in black, existing building footprints are shown in dark gray. While rooftops and parking lots are similarly impervious, runoff from paved surfaces is typically more polluted and harder to control than pollution from building rooftops. Different strategies are appropriate for collecting and treating stormwater before it can be reused, infiltrated, or slowly released back into more traditional stormwater systems.

Site Diagram Showing Surfaces and Underground Stormwater Conveyance

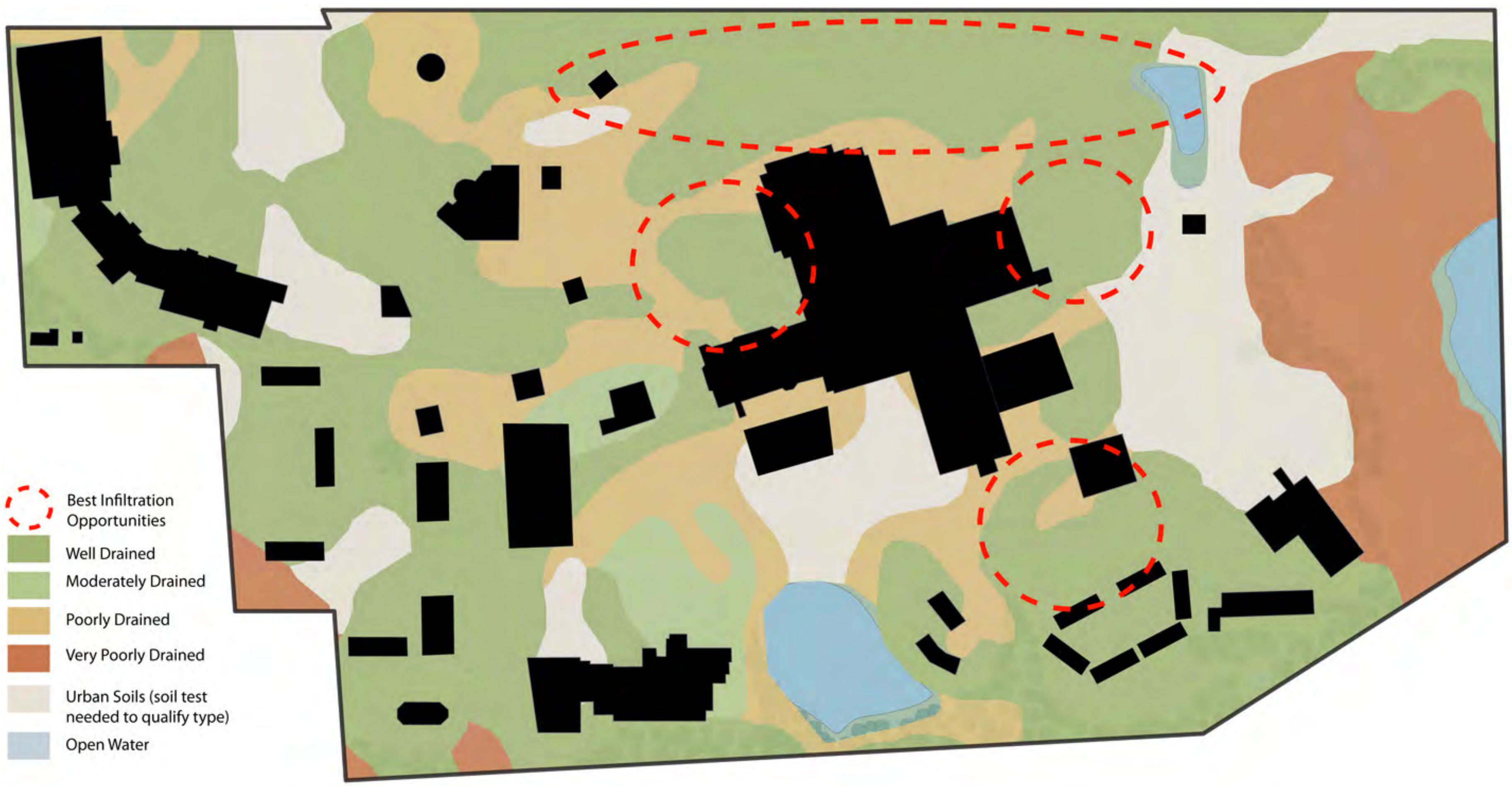
ABOVE : Diagram showing building footprints (existing and proposed), water bodies and existing ground cover. Also showing underground storm sewer drainage that conveys stormwater runoff into surface water bodies on site.

Site Diagram Showing Surface Runoff Direction and Underground Stormwater Conveyance



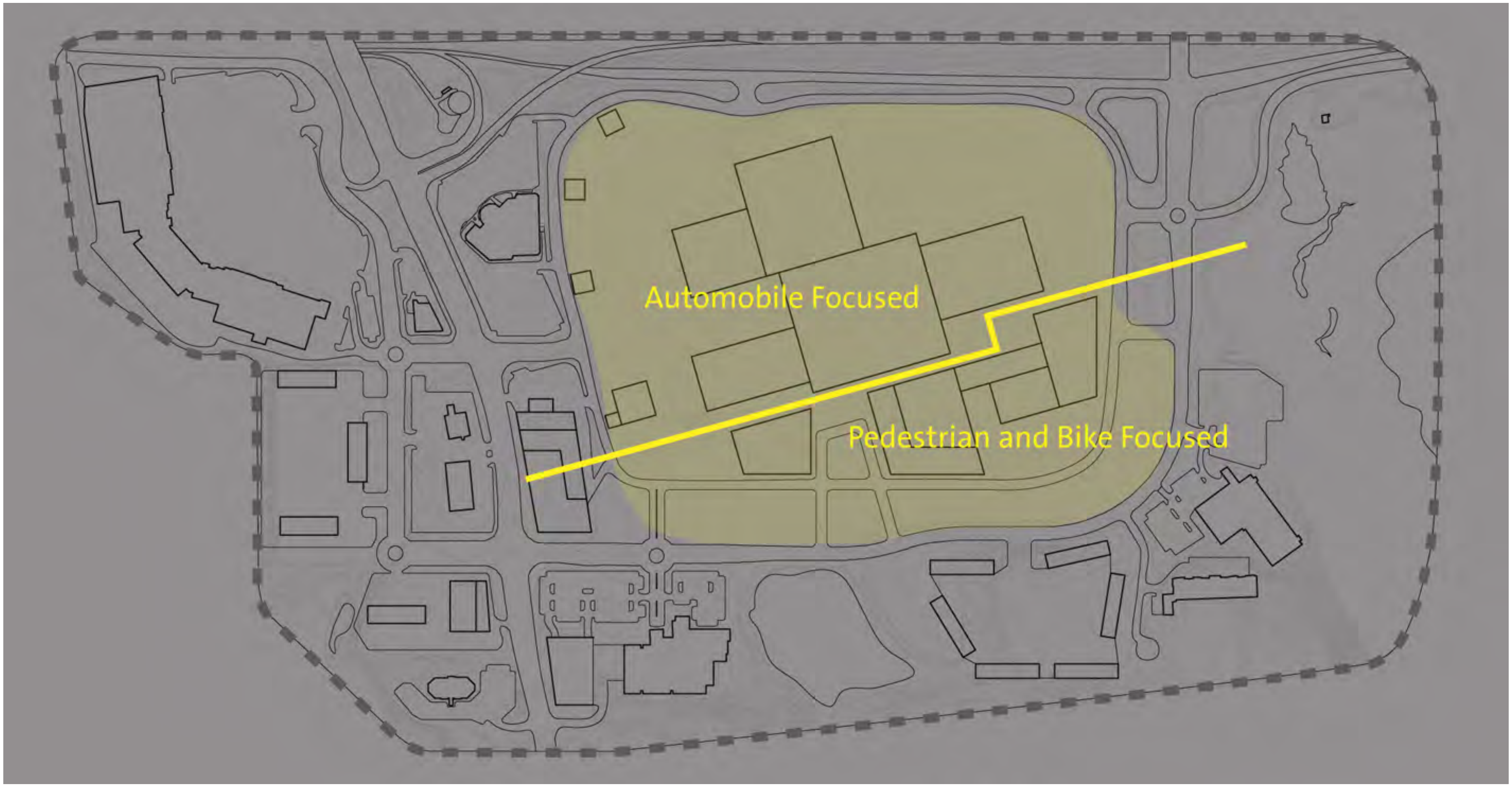
ABOVE : Water movement diagram shows direction of surface and subsurface water flows across the site. Existing topography and ground cover determine the direction of stormwater runoff. Water is collected throughout the site, and conveyed through underground stormwater sewers into retention ponds, wetlands and Carver lake. When stormwater is conveyed in this manner without any treatment or filtration, pollutants and sediment from parking lots are carried with the runoff into surrounding water bodies. Peak water discharge into these water bodies causes erosion of banks, depositing of sediment and pollution from paved surfaces, and increased water temperature in receiving water bodies, all of which degrade water and habitat quality. Localized flash flooding can also result from this type of stormwater system, which can result in property damage and further water pollution.

Site Diagram Showing Soil Drainage Properties and Ideal Water Infiltration Areas



ABOVE : Diagram shows building footprints (existing and proposed), water bodies, and soils on site. Stormwater infiltration will be most successful in areas with well drained soils. These locations should be considered as first priority for rain gardens, pervious paving, or underground infiltration areas. To ensure success of these strategies soil tests are needed to confirm drainage properties and possible contamination levels of soils in infiltration areas. Infiltrating stormwater on higher ground is preferable to avoid flooding in low lying areas. Tree trenches or bioswales with underground overflow pipes to well drained soils can be utilized in areas where soil drainage is poor or unknown. Infiltrating water through contaminated soils causes groundwater contamination.

Site Diagram Showing Ideal Automobile and Pedestrian Focus Areas



ABOVE: Scale and density are important characteristics of this site. Currently, the scale and density of the site are appropriate for automobiles but hostile to pedestrians. Distances between destinations, the number of traffic lanes to be crossed, and the general exposed nature of pedestrian movement across the site creates an intimidating pedestrian experience. Trail connections across the site will improve the pedestrian experience and accessibility of the site if designed properly. Based on the proposed redevelopment in the areas to the south of Ridgedale Mall, and the site's relationship to the freeway, pedestrian and bike areas should be focused to the south of the mall. By creating an area of higher density that is scaled and designed to maximize the pedestrian experience, public spaces will be more successful than if they are spread out across the site. In addition, public spaces to the south of the building that are properly vegetated will be more comfortable year round than plaza spaces that are shaded by the building in cooler seasons. The automobile focused areas to the north of the site should include clearly defined pedestrian pathways that are appropriately scaled and separated from traffic to ensure the safety and comfort as guests move across the parking areas.

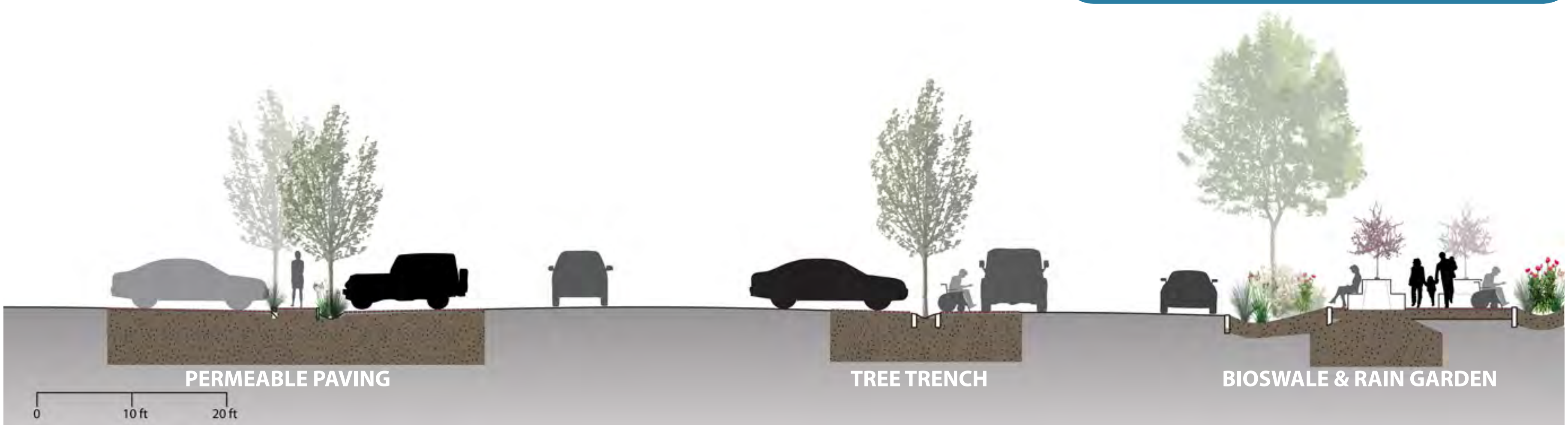
ABOVE: A possible view of Ridgedale from the parking lot. This example of a parking lot intervention includes tree trenches, permeable paving in parking areas, bioswales, rain gardens, and a designated pedestrian area at the edge of the parking lot that safely leads visitors to the nearest mall entrance.

PARKING LOT STRATEGIES

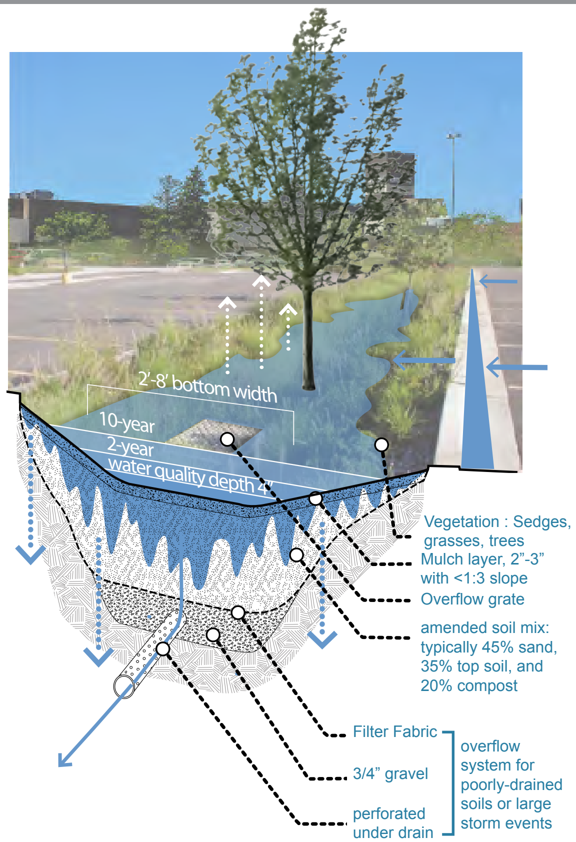
The goal of parking lot strategies is to collect, treat & infiltrate stormwater as close to the sources as possible. Combine appropriate strategies to improve pedestrian experience and safety while reducing the negative ecological impacts of large parking areas.

COMBINED STRATEGIES:

- Permeable concrete
- Permeable pavers
- (Grass pavers - not shown here)
- Tree trenches & pits
- Bioswales
- Rain gardens



ABOVE: Parking lot trees with permeable paving and minimal bioswales capture storm water and provide shade while improving views and temperature in the parking lot. Larger bioswales in strategic areas create pedestrian oases in the parking lot with a safe pedestrian path from the parking areas to the shopping mall.



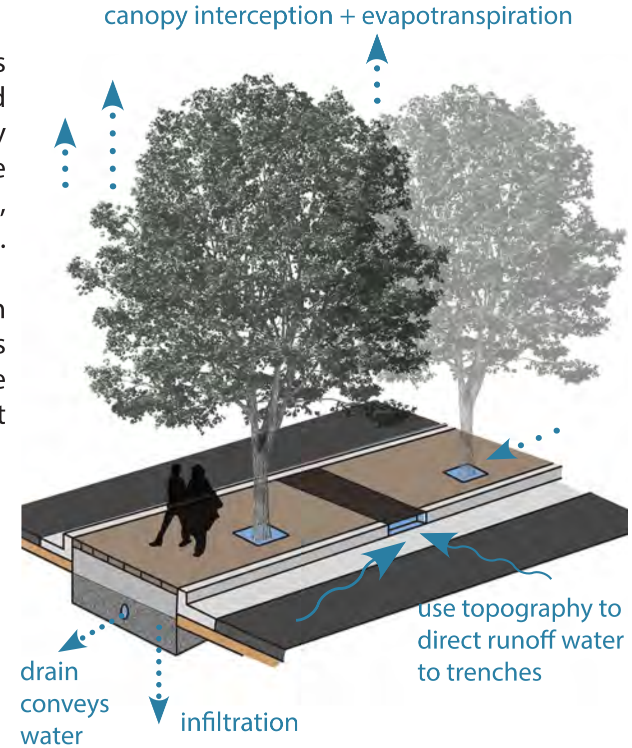
ABOVE: Parking lot bioswale diagram. Runoff from impervious parking lot surfaces is directed to nearby bioswales where it is collected, treated and slowly infiltrated. Trees and plants in bioswales help cool, shade, and beatify the parking lot in addition to treating stormwater runoff.

VEGETATION & PEDESTRIAN PATHS

Trees, bioswales and rain gardens collect, and treat stormwater. Once collected in these systems, the clean water can be infiltrated where appropriate, or slowly released into traditional stormwater infrastructure systems. Trees and plants collect rainwater in their canopies, and will absorb stored subsurface water through their roots and release it back into the atmosphere through the process of transpiration. When appropriately designed, these systems can also create critical habitat and linkage systems between larger habitat areas.

These planted, green infrastructure systems can be used to create buffers between cars and pedestrians which improve pedestrian safety and comfort. Trees and plants also provide shade and cooling, protection from elements, interesting views, and scale to pedestrian areas.

Permeable paving is appropriate for pedestrian and parking areas. These paving systems create good drainage opportunities while incorporating a unique material character that adds a sense of scale to pedestrian areas.

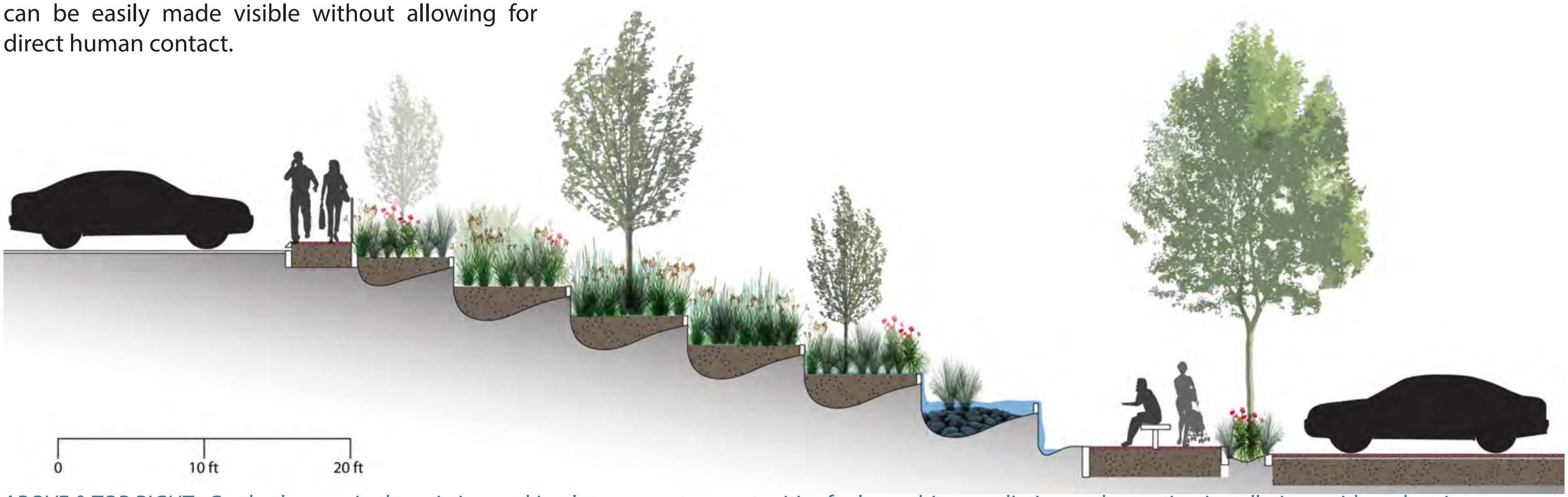


RIGHT: Tree trench diagram shows movement of water and space for a safe, identifiable pedestrian walkway in the parking lot. Tree trenches are capable of storing large volumes of water underground and in the tree canopy. Once collected, water can be infiltrated or conveyed slowly to traditional stormwater infrastructure. Water stored in the tree trench soils are further dispersed by the trees through the process of transpiration.

GRADE CHANGES

There are currently several areas throughout the site where the grade changes significantly, so that entrances from the parking lot access the first and second levels of the mall. These grade changes are underutilized, but present unique design opportunities for creating a sense of place and distinct identity for each mall entrance. A design that takes advantage of site topography will help break up the expansive parking lot areas and introduce unique places into an otherwise homogenous landscape.

Grade changes are excellent places for larger rain gardens, bioswales, pedestrian areas, and water features. Allowing water to cascade creates pleasant sound, and purifies the water. Water in these areas can be easily made visible without allowing for direct human contact.



ABOVE & TOP RIGHT: Grade changes in the existing parking lot are great opportunities for larger bioremediation and retention installations with pedestrian areas. These featured areas can provide unique mall entrance experiences and help orient and place visitors in the outdoor spaces.

DRINKING WATER CONSERVATION

Drinking, or potable, water conservation is the simplest, most economical and most important goal for future development on this site. Conservation of potable water happens at the building and landscape scales. High efficiency fixtures can easily reduce potable water consumption by 30%. Water saving fixtures can also decrease the energy needed to heat and cool water.

Eliminating the use of potable water for irrigation at the mall and in the surrounding areas will have a tremendous impact on the water use on this site. Replacing turf grass with native plantings will reduce runoff, irrigation demand and energy and chemicals required for maintenance. Properly channeled runoff from parking lots can supplement irrigation. Minimally treated grey water and harvested rainwater can replace drinking water for irrigation uses.

Water conservation techniques can be displayed so that visitors to the mall are educated about water conservation and familiarized with the technologies in a comfortable way. People are more likely to make steps to conserve water in their own homes if they have an understanding of the benefits, and are comfortable with the technologies.

Use of low-flow fixtures can easily reduce potable water use by 30%

Reuse of non-potable water for flushing & irrigation purposes gives additional reduction of 22% with an overall reduction of 52%

Treatment of Mall black+grey water using Living Machine gives additional reduction of 3% with overall reduction of site potable water of 55%

BUILDING WATER STRATEGIES

Building strategies can be considered as indoor and outdoor opportunities, both of which can improve stormwater and building water cycles.

Our current infrastructure model separates water into three distinct categories: stormwater, potable water, and wastewater, rather than understanding how different types of water are interconnected. We treat stormwater and wastewater as a problem that must be hidden and discarded immediately rather than as the valuable resource that all water is. At the same time, drinking water is consumed and wasted in non-potable applications, such as toilet flushing and irrigation.

COMBINED BUILDING STRATEGIES:

- Green roof
- Rooftop gardens
- Native plantings
- Rainwater harvesting
- Water conservation & reuse
- Water features
- Living Machine

LEFT: WATER USE FOR ONE PERSON One person staying in a hotel, uses much more water than one person eating at a restaurant or visiting the mall. Water conservation efforts in new hotel spaces is important.

LEFT: WATER USE BASED ON PROGRAM While one visitor to a hotel uses more water than one to the mall, the number of visitors to the mall mean that combined, the mall's use of water is much greater than the hotel's use. Water conservation efforts are important across programs.

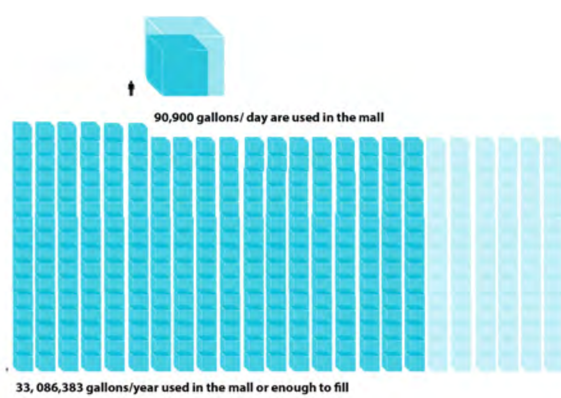
WATER CONSERVATION

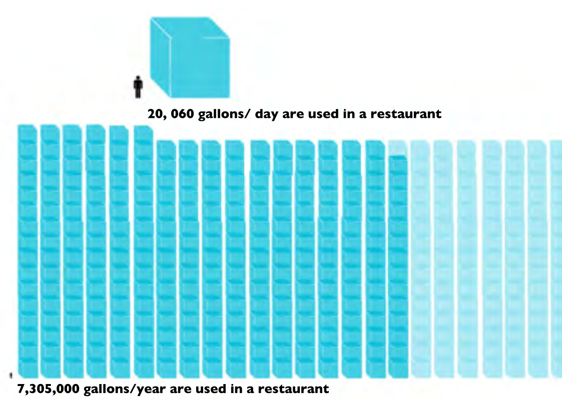
This series of diagrams shows how much potable water can be saved through simple conservation efforts such as low flow fixtures. Conserving water will reduce the site's carbon footprint by saving energy at both the site and off-site locations.

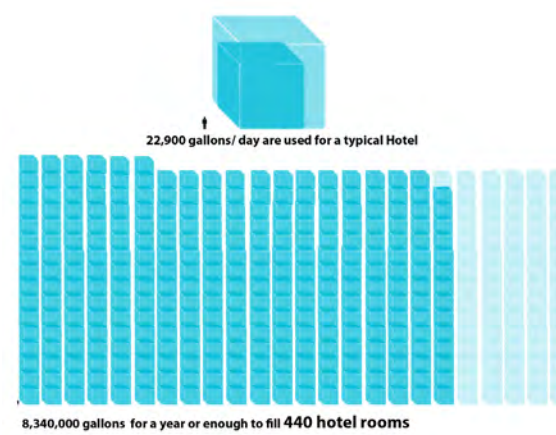
COMBINED STRATEGIES:

- Rainwater harvesting
- Water conservation & reuse
- Low flow fixtures
- Living Machines

BELOW: Water conservation efforts in each area are important. By reducing the water conservation at a small scale, the compounded impact is profound.







GREEN ROOFS

Green roofs have the ability to replace some of the landscape that is displaced by development. The benefits of green roofs range from reducing storm water runoff by filtering and collecting rainwater, to cooling the building during summer months, and providing year round habitat for migratory birds and insects. Uninhabited green roofs on the site can be a visible icon of the site from the freeway.

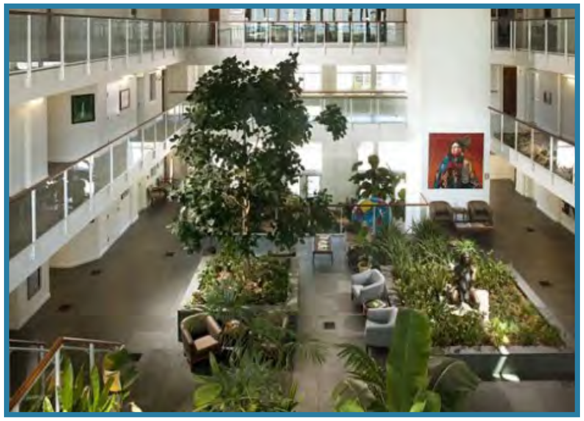
The site currently has approximately 1.5 million square feet of unused rooftop, and further development of the site will only increase that number. This means that 14% of the site has unmet real estate potential. If green roofs were added to every building on this site, whether or not they were inhabited, they would recreate 1.5 million sf of displaced green space. This would affect stormwater runoff, urban heat from the site, and habitat quality and connectivity of adjacent natural areas. Alternatively, this could create 1.5 million sf of park space, or productive urban agriculture.

Green roofs add weight to the roof, and are not always as appropriate for installation on existing buildings as on new construction. The environmental and aesthetic benefits of green roofs are present even if they are not designed to be inhabited by people.

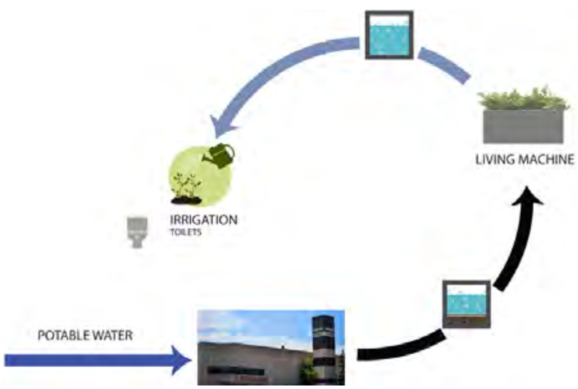
We recommend a policy that requires a minimum standard for intensive green roof on all new buildings on site, and at least 50% of renovated existing structures.

ABOVE: Rooftops provide opportunities for urban gardens. Use of greenhouses on rooftops can recapture waste heat from the building below and extend the growing season for year round productivity.

BELOW: A potential view of Ridgedale Mall from a rooftop park on an adjacent building. This site currently has 1.5 million sf of wasted, rooftop real estate.



ABOVE: The Living Machine installed by Worrell Water Technologies in the San Francisco Public Utilities Commission lobby treats building wastewater for reuse in irrigation, toilets, and building maintenance



ABOVE: Diagram showing how water is recycled on-site with a Living Machine. Potable water is used for potable uses in the building, wastewater is treated and disinfected in the Living Machine to high-quality, non-potable standards. It is stored, then used for irrigation and toilets. The Living Machine could be incorporated into the mall atrium, or in a freestanding greenhouse.

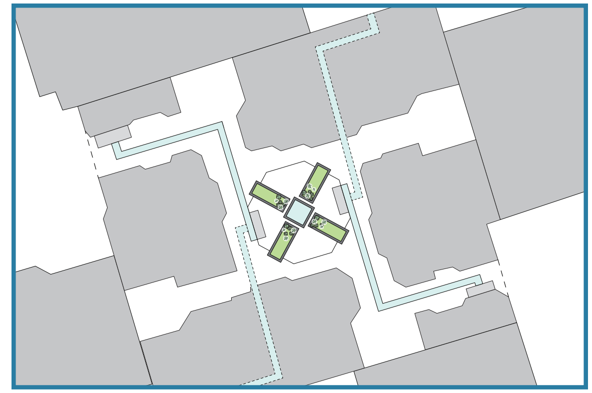
INDOOR LIVING MACHINE IN THE RIDGEDALE MALL ATRIUM

The central mall atrium would be one ideal location for a Living Machine. A Living Machine (Worrell Water Technologies) is a hybridized wetland wastewater treatment system. These systems rely on plants and microorganisms to extract nutrients, minerals, impurities and bacteria from grey and black water. Living Machines are safe, effective, and can be designed as interior gardens.

A beautiful Living Machine in the mall atrium could be both iconic and educational. Plants would take advantage of the ambient building temperature, reducing the operational costs that are associated with heating a freestanding greenhouse structure. This location in the mall atrium would be highly visible to mall visitors, and could be designed as a beautiful indoor winter garden.

As an indoor atrium garden, a Living Machine would also condition the interior space. Indoor plants provide oxygen, air filtration, and add humidity to the air. In Minnesota, indoor gardens can have psychological benefits in addition to functional benefits.

A Living Machine located in the mall would require changes to building plumbing, but would easily accommodate the building's gray, black and non-potable water demands without excessive pumping.



ABOVE: Diagram showing the potential location of a Living Machine in the mall atrium to treat building wastewater for reuse on site.

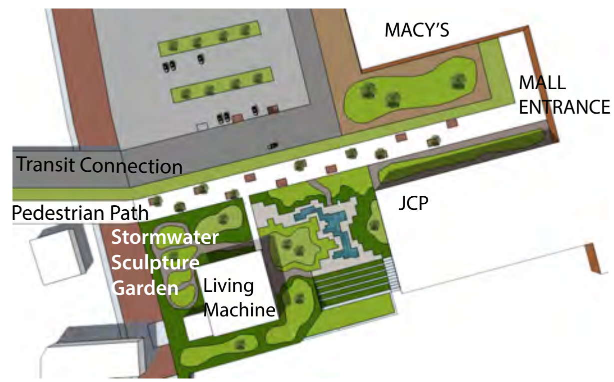
BELOW: A whimsical view of the mall atrium showing a planted space that could be a Living Machine below a water feature showcasing rainwater harvested from the roof of the building.

FREESTANDING LIVING MACHINE IN THE REPURPOSED FIRESTONE CAR CARE CENTER

A freestanding Living Machine, located centrally on the site, could serve as a district water treatment facility. A freestanding building could be a public space and education center that would provide different opportunities and challenges to the site than a Living Machine enclosed within the mall. The Living Machine shown below repurposes the Firestone Car Care Center building.

An external Living Machine would have added heating costs that an indoor atrium Living Machine would avoid, but could operate independently of the mall. A freestanding greenhouse Living Machine could become an icon for the larger site while diversifying the site attractions, and be accessible to visitors to the area who are not shopping at the mall.

Like any Living Machine, a freestanding operation could be a beautiful indoor garden, with space for special events.



ABOVE: Diagram showing location of a freestanding Living Machine and stormwater sculpture garden as an iconic entry plaza and education center.

LEFT: View of the Stormwater Sculpture Garden and Living Machine education center from re-purposed Firestone Car Care Center. This iconic public space, located at the main entrance to Ridgedale Mall would be visible from the freeway.

ABOVE: Rendered image of an expressive, educational intervention outside the mall that explores ways to communicate sustainable water measures to the public. A sculptural 'gutter' feature and cistern showcases water collected from the building rooftop.

The strongest characteristic of the site is its massive, undifferentiated horizontal parking lot surface. This would be a perfect canvas to communicate the nature of the direct link between storm water from this parking lot and the natural environment. As the image of the natural environment is worn away by car tires, the piece asks the question: Where did it go?

CULTURAL IMPACT

The most powerful opportunity for designing a sustainable water cycle on the Ridgedale Mall site is its ability to showcase the beauty of sustainable infrastructures in a meaningful and educational way.

This project is a great opportunity for the City of Minnetonka and the Ridgedale area community of businesses and residents to become world leaders, by embracing a sustainable water cycle through a beautiful and iconic design.

Sustainable infrastructures are responsive to their context and climate. A sustainable redesign of the Ridgedale Center would make it a truly unique and beautiful shopping destination.

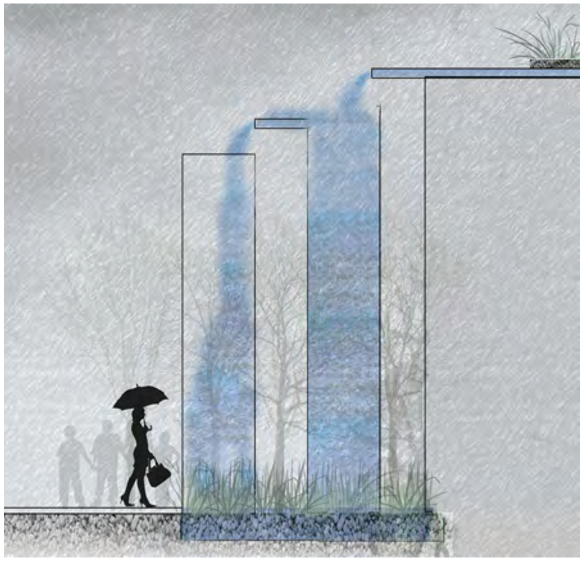
COMBINED STRATEGIES:
- Native planting
- Bioswales
- Rain gardens
- Tree trenches & pits
- Permeable concrete & pavers
- Green roofs
- Rain water harvesting
- Non-potable reuse
- Low flow fixtures
- Living Machines

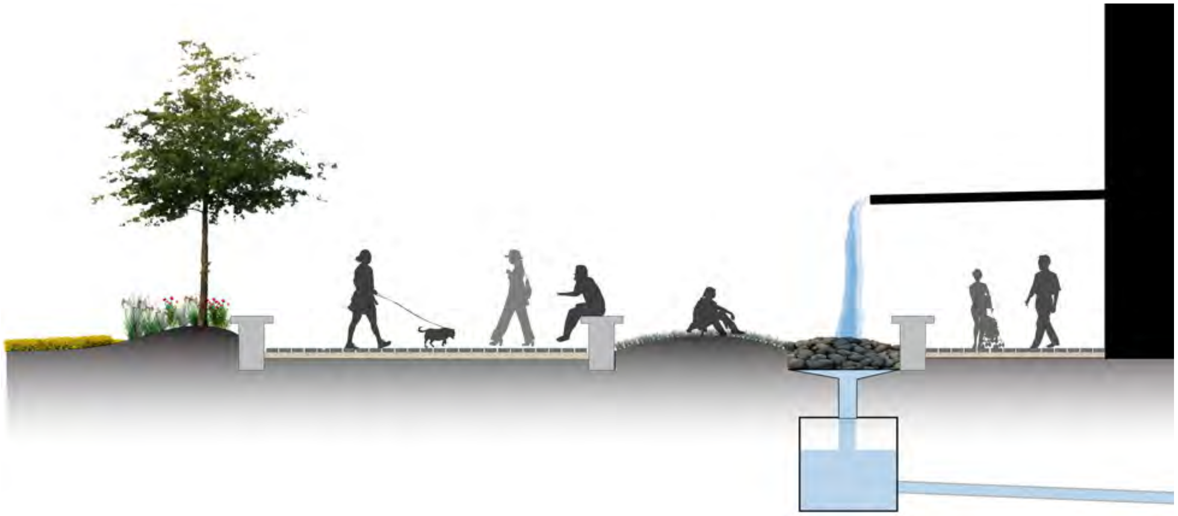
EXPRESSION OF RAINWATER HARVESTING

Rainwater harvesting can be practical and expressive. The movement of water provides a great opportunity for functioning sculptural elements and dramatic building entrances. Drawing attention to the collection and movement of rain water can celebrate this valuable resource while engaging and educating visitors.

Buildings are designed with rooftop drainage, making downspouts easy places to collect water from the roof. Water that first runs through a green roof system is typically filtered and can be used without further treatment. Unfiltered water may need minimal treatment before it can be used for non-potable uses.

Once collected, water moves from the building rooftops to cisterns for storage. Gutters and water features that channel water from its source to storage can also filter water and be beautiful site amenities.





RIGHT: The movement of water from building rooftops to water storage or rainwater gardens can be a beautiful site amenity, while reducing runoff.

ABOVE & LEFT: Pedestrian trails and paths in parking lots adjacent to roadways can be buffered from traffic by bioswales and rain gardens. Using natural features to separate pedestrians from cars can make pedestrian areas more comfortable. Trails that cross the site that are surrounded by natural features can create critical linkages between habitat areas.

PUBLIC SPACE & TRAIL ACCESSIBILITY

Redesigning the Ridgedale Center area to accommodate stormwater on site would be a great opportunity to restore existing water resources and connect this community center to its surrounding natural resources. Trail connections across the site improve site accessibility to the local businesses and natural resources.

Integration of pedestrian areas with rain gardens and bioswales across the site create important habitat connections, and improve walkability.

Green roofs and Living Machines provide unique opportunities for public space.

COMBINED STRATEGIES:

- Bioswales
- Rain gardens
- Tree trenches & pits
- Permeable concrete & pavers
- Wetland reconstruction
- Green roofs
- Living Machines

ABOVE : Restored wetlands adjacent to Ridgedale are connected with area trails across the site become a beautiful amenity. Trail connections improve accessibility to the mall and natural resources.

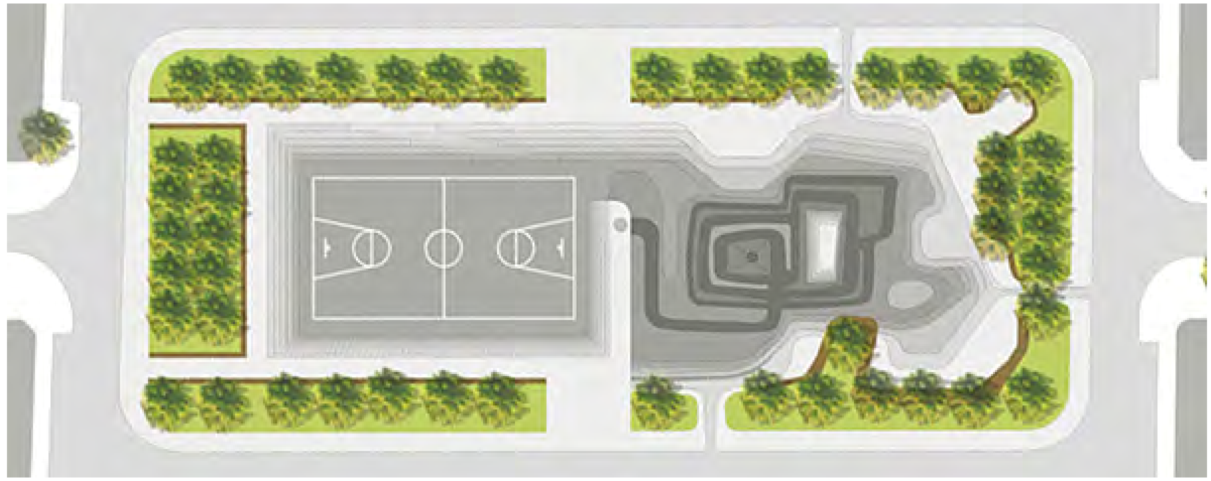
PRECEDENT: EXPRESSION OF WATER & SEASONS

WATER SQUARES

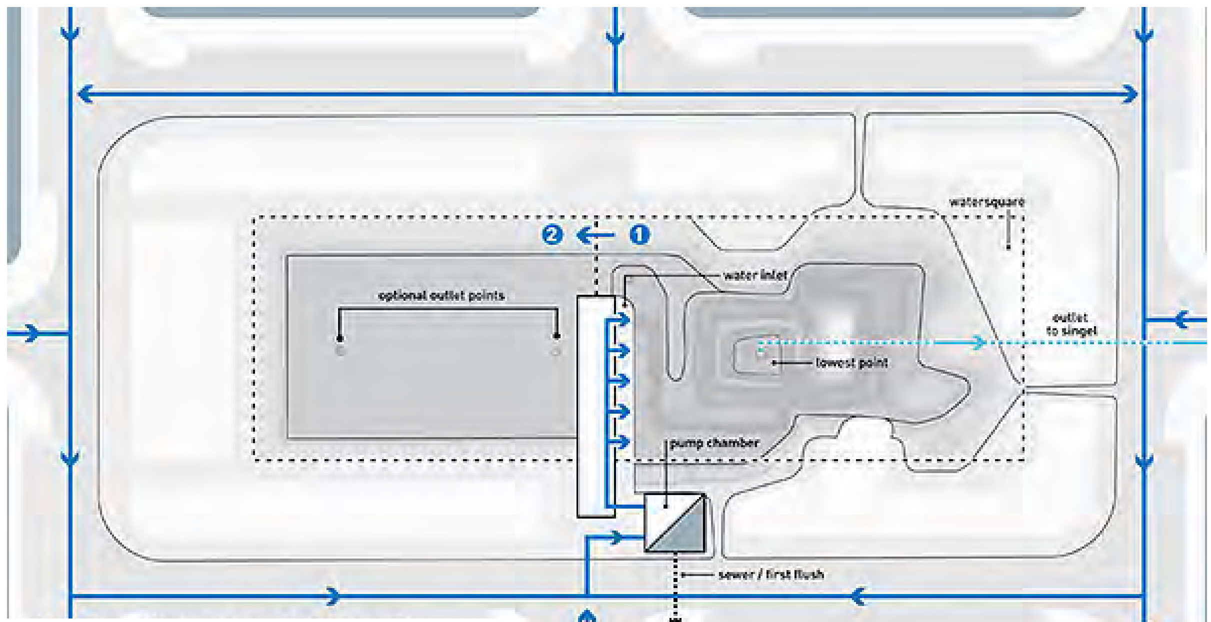
YEAR: 2006-2010
LOCATION: Rotterdam, NL
CLIENT: Rotterdam Climate Proof
City of Rotterdam
Netherlands Architecture Fund
STATUS: Typology research, approved policy on Municipal level, Pilot Feasibility Study, Comic Book

The Water Squares project is a conceptual study completed by the city of Rotterdam to explore opportunities for urban parks to serve as stormwater collection spaces. This conceptual project has informed city policy, resulting in built projects that satisfy the goals of Water Squares. These park spaces are designed to intentionally flood during seasonal rain events. This conceptual project was a response to increased urban flooding due to heavy rainfall associated with climate change.

Most of the time the water square will be dry and in use as a recreational space. The exemplary design for the watersquare is divided into two main parts: a sports area and a hilly playground. The space is captured by a green frame of grass and trees. When heavy rains occur, rainwater that is collected from the neighborhood will flow visibly and audibly into the water square. Short cloudbursts will only fill parts of the square. When the rain continues, more and more parts of the water square will gradually be filled with water. The rainwater is filtered before running into the square.
-DE URBANISTEN

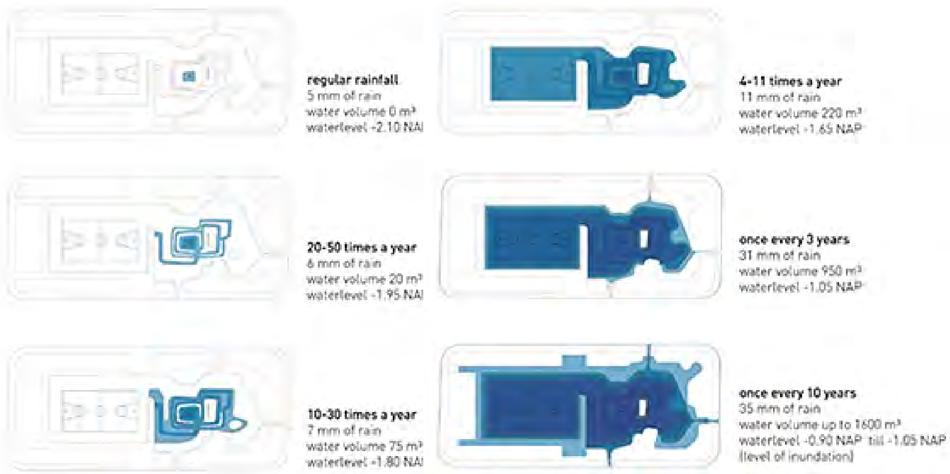


TYPICAL SUMMER CONDITION (Non-flood state)



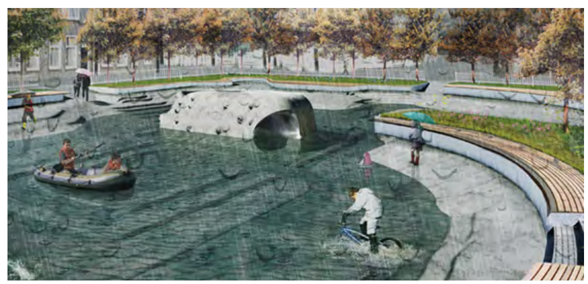
HOW THE WATERSQUARE WORKS TECHNICALLY

SOURCE: http://www.urbanisten.nl/wp/?portfolio=waterpleinen

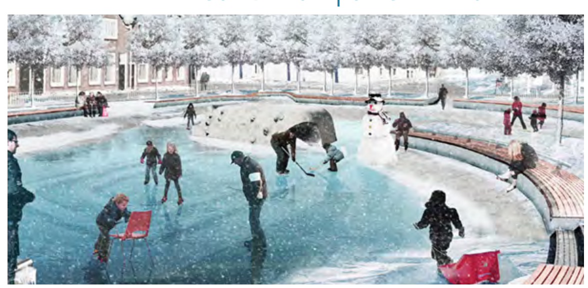


ABOVE & BELOW: The Water Squares project is a park landscape that is designed to intentionally flood during major rain events to alleviate flooding in other areas. This urban landscape provides safe temporary water storage during large storm events. It is a functional public space when it is not needed for water storage.


TYPICAL SUMMER CONDITION | PARK


HEAVY RAINFALL CONDITION | ONCE ANNUALLY


LIGHT RAIN CONDITION |30 TIMES ANNUALLY


WINTER CONDITION | FLOODED FOR ICE SKATING

FLOOD-ABLE PUBLIC SPACES PROVIDE TEMPORARY WATER STORAGE DURING MAJOR RAIN EVENTS

The Water Squares project is an interesting precedent for the Ridgedale Mall area for several reasons. While this project is conceptual, it has informed several other projects that are in the process of being built in Rotterdam.

This project shows how landscapes can be designed to flood intentionally. These areas can provide the short term storage needed during storm events of all sizes, but are functional public spaces when they are not flooded.

Another exciting opportunity in this project is the opportunity for people to observe changes in seasons and weather, and to better understand the natural water cycle through interaction.

Providing opportunities for people, especially children, to interact, either passively or directly with water, can be a meaningful and powerful learning experience. These types of unique spaces are meaningful public places.

There are many opportunities on the Ridgedale Mall site and surrounding areas where a public plaza and play space could be designed to function in a similar manner to the Water Squares. This type of plaza could be designed to offer year round outdoor activity.

ECOLOGICAL & CULTURAL IMPACT OF DESIGNS

This series of graphs bundle various strategies into three groups, "Transitional", "Advanced" and "Revolutionary", to illustrate the impact and relevance of individual strategies, and how they might be combined to meet various ecological goals. By thinking about the larger ecological goals of the project and understanding which strategies will contribute to those larger goals, these tools can help prioritize strategies and influence their integration into a design.

A "Transitional" design can be considered a "Green" design. The goal of a transitional design is to improve human quality of life while reducing the negative impacts of human behavior and the urban landscape, or to "do less harm" to the natural environment.

An "Advanced" design can be considered a "Sustainable" design. The goal of an advanced design is to minimize the negative impacts of human behavior and the urban environment while improving human quality of life. A sustainable design will aim to "do no harm" and thereby protect human quality of life into the future.

A "Revolutionary" design can be considered a "Regenerative" design. The goal of a revolutionary design is to create or provide more resources than human life consumes, or to "do more good" for the environment. This design maximizes the benefit of the urban landscape for all human, and non-human, life.

TRANSITIONAL - "Green"

Green Goal: **Do less harm**

Design incorporates minimum standards and technologies to improve human experience of the site while reducing the negative impact of the urban landscape on surrounding natural areas.

Design engages and informs visitors about the importance of potable water conservation and ecological stormwater management practices.

Design follows proven trends and established best management practices.

ADVANCED - "Sustainable"

Sustainable Goal: **Do no harm**

Design takes an active stance to minimize the negative impact of the urban landscape on the surrounding natural areas. Improved human experience of the site is a central focus, with an emphasis on ecological habitat quality and connectivity.

Design emphasizes the beauty and quality of habitats, while going beyond minimum standards for potable water conservation and stormwater management.

Design takes a balanced approach to sustainability that innovates in some areas, and follows proven trends in others.

REVOLUTIONARY - "Regenerative"

Regenerative Goal: **Do more good**

Design takes an aggressive stance, with the goal to maximize the benefit of the site to humans and the larger ecological system through the use of the regenerative strategies.

Design is innovative, with the goal of becoming an example to other shopping centers that showcases the possibilities in finding new ways to engage underutilized real estate.

Design incorporates proven technologies while innovating strategies and pushing the limits of regenerative design.

POTABLE WATER CONSERVATION

How water conservation strategies are selected and implemented through design affects their ecological value. Water conservation is important because it impacts larger ecosystems, off-site energy use and the carbon footprint of a building or site. As more advanced strategies are integrated into a design, such as rain water Harvesting for non-potable reuse, conservation is a critical first step to ensure that harvested water meets demand.

TRANSITIONAL - "Green"

Green Goal: **Do less harm**
Reduce negative ecological impacts of Ridgedale. Conservation of potable water on site should be a first priority.

- **Create actionable goals for site water conservation** that will inspire site visitors and residents to lower waste of potable water.
- **Use design features to engage and inform the pubic** about the importance of water conservation and available technologies.
- **Low flow fixtures** installed in all new development and renovations of existing structures
- **Native plantings** in existing gardens will require less irrigation. Replacing lawns with native grasses will reduce maintenance and irrigation costs.
- **Rain water harvesting** from building rooftops for use in site irrigation.

ADVANCED - "Sustainable"

Sustainable Goal: **Do no harm**
Minimize negative ecological impacts of Ridgedale. Potable water only used for potable uses in commercial.

- Create actionable goals for water conservation
- Use design to inform the public about mall water conservation efforts
- Low flow fixtures
- Native plantings

- **Rain water harvesting & non-potable reuse** replaces all potable water use for outdoor irrigation and commercial non-potable indoor uses.

REVOLUTIONARY - "Regenerative"

Regenerative Goal: **Do more good**
Maximize ecological benefit of Ridgedale Shopping Center. Potable water only used for potable uses in commercial and residential buildings.

- Create actionable goals for water conservation
- Use design to inform the public about mall water conservation efforts
- Low flow fixtures
- Native plantings
- Rain water harvesting & non-potable reuse

- **Rain water harvesting & non-potable reuse** replaces all potable water use for all non-potable indoor and outdoor uses.
- **Living Machine** treats mall area wastewater for non-potable reuse. Water reuse connections created across larger site and commercial and residential uses.

STORMWATER STRATEGIES

Which stormwater strategies are selected, and how they are implemented through design will effect their ecological value. If the strategies selected are implemented with ecological goals in mind, they have the potential to create a beautiful and ecologically significant environment that enhances the pedestrian experience and educates visitors.

TRANSITIONAL - "Green"

Green Goal: **Do less harm**
Reduce negative ecological impacts of Ridgedale. 1" storm event can be captured on-site. This would meet the State Minimal Impact Design Standards for on-site capture of 1.1" of runoff from impervious surfaces.

- **Bioswales & rain gardens** collect and infiltrate parking lot runoff where soil conditions are appropriate.
- **Permeable concrete & pavers** should replace non-porous paving as appropriate
- **Tree trenches & pits** where infiltration is not ideal
- **Green roofs** recommended where appropriate on existing structures and on majority of new development.
- **Rain water harvesting** captures rooftop runoff for irrigation use.

ADVANCED - "Sustainable"

Sustainable Goal: **Do no harm**
Minimize negative ecological impacts of Ridgedale. 2.8" storm event can be captured on-site. Stormwater design will integrate pedestrian areas with strategies to create beautiful and educational experiences. Ecological habitat creation and connectivity are considered in the design.

- Bioswales
- Rain gardens
- Tree trenches & pits
- Permeable concrete & pavers

- **Rain water harvesting** takes advantage of rainfall on the site to replace non-potable use of potable water while reducing urban stormwater runoff.
- **Green roofs establish intentional habitat connections** between on-site and nearby ecological and cultural amenities. Designs go beyond the minimum requirements for stormwater management.

REVOLUTIONARY - "Regenerative"

Regenerative Goal: **Do more good**
Maximize ecological benefit of Ridgedale Shopping Center. 2.8" storm event can be captured on-site. Site Stormwater design will improve pedestrian experience while maximizing ecological value of the site and ensuring habitat quality and connectivity.

- Rain water harvesting
- Bioswales
- Rain gardens
- Tree trenches & pits
- Permeable concrete & pavers
- Rain water harvesting & non-potable Reuse

- **Green roofs** on 100% of all new development for purpose of stormwater and displaced green space

USING THE WATER TOOLKIT

The purpose of the water toolkit in the following pages is to provide explanations and definitions of the terms used throughout this report. The technologies listed here were used throughout this project in different applications to meet potable, waste- and storm- water goals for the project.

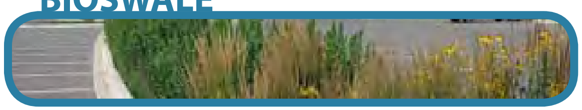
Strategies in the toolkit have been arranged into four categories (greenscapes, hardscapes, building, wastewater).

The chart to the right of each page provides further information on the relevant impact of each strategy on stormwater and potable water.

NATIVE PLANTING

RAIN GARDEN

BIOSWALE

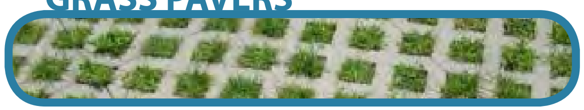


TREE PITS & TRENCHES

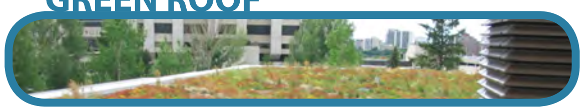
PERVIOUS PAVERS

PERMEABLE CONCRETE

GRASS PAVERS



GREEN ROOF



RAINWATER HARVESTING

LIVING MACHINES

WATER TOOLKIT

Treat all water as a valuable resource. Stormwater Strategies are used to reduce runoff and subsequent water pollution, by collecting, treating and infiltrating stormwater as close to source as possible. Potable Water Strategies are used to conserve drinking water and promote responsible water use.

	STORMWATER	POTABLE WATER
GREENSCAPES:		
• Native planting	●	●
• Bioswales	●	
• Rain gardens	●	
HARDSCAPES:		
• Tree trenches & pits	●	
• Permeable concrete	●	
• Permeable pavers	●	
• Grass pavers	●	
BUILDING:		
• Green roofs	○	●
• Rain water harvesting	●	●
• Non-potable reuse	○	●
• Low flow fixtures		●
WASTEWATER:		
• Living Machines	○	●

NATIVE PLANTING

NATIVE PLANTS are accustomed to Minnesota climate and have deep root systems, require less water to irrigate and help infiltrate stormwater. They are being increasingly used for gardening and landscaping. They can provide natural beauty, cost-effective landscaping alternatives, environmental services, and habitat for wildlife.

BIOSWALE

A ***BIOSWALE*** or vegetated swale is a form of bioretention used to partially treat water quality, attenuate flooding potential and convey stormwater away from critical infrastructure. These systems are linear, with length to width dimensions much greater than the more typical 2:1 applied to bioretention cells. Like rain gardens, bioswales can be used to collect runoff from adjacent impervious surfaces, such as rooftops, driveways, parking lots, and lawns.

RAIN GARDEN

A ***RAIN GARDEN*** is a garden of native shrubs, perennials, and flowers planted in a small depression, which is generally formed on a natural slope. It is designed to temporarily hold and infiltrate rain water runoff that flows from roofs, driveways, patios or lawns.

Rain gardens are effective in removing up to 90% of nutrients and chemicals and up to 80% of sediments from the rainwater runoff. Compared to a conventional lawn, rain gardens allow for 30% more water to soak into the ground. Rain gardens can also be designed as specific habitats, such as butterfly gardens.

WATER TOOLKIT

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GREENSCAPES:		
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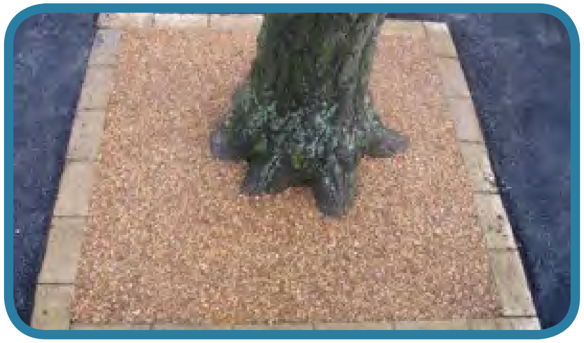
• Rain gardens	●	
HARDSCAPES:		
• Tree trenches & pits	●	
• Permeable concrete	●	
• Permeable pavers	●	
• Grass pavers	●	
BUILDING:		
• Green roofs	○	●
• Rain water harvesting	●	●
• Non-potable reuse	○	●
• Low flow fixtures		●
WASTEWATER:		
• Living Machines	○	●

TREE TRENCHES & PITS



TREE PITS & TRENCHES consist of an underground structure and above ground plantings which collect and treat stormwater using bioretention. Bioretention systems collect and filter stormwater through layers of mulch, soil and plant root systems, where pollutants such as bacteria, nitrogen, phosphorus, heavy metals, oil and grease are retained, degraded and absorbed.

Once treated in the tree trench, stormwater is evapotranspired by the trees, infiltrated into the ground or, if infiltration is not appropriate, discharged slowly into a traditional stormwater drainage system.

Trees planted in tree trenches also provide opportunities for tree cover and shade in parking lots, reducing heat gain.

PERVIOUS PAVERS

PERVIOUS PAVERS can be made of brick, stone, concrete block, and recycled plastic bottles among other materials.

Pervious paving surfaces are areas covered with highly porous material that allow water from precipitation to pass through, yet are strong and durable enough to support vehicular or pedestrian traffic. The value of porous surfaces as a low impact development practice is in reducing surface runoff and recharging ground water levels.

WATER TOOLKIT

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• Rain gardens	●	
HARDSCAPES:		
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• Permeable concrete	●	
• Permeable pavers	●	
• Grass pavers	●	
BUILDING:		
• Green roofs	○	●
• Rain water harvesting	●	●
• Non-potable reuse	○	●
• Low flow fixtures		●
WASTEWATER:		
• Living Machines	○	●

PERMEABLE CONCRETE

PERMEABLE or PERVIOUS CONCRETE is a large aggregate concrete mixture that is poured like other types of concrete. The large aggregate allows for a matrix of connected air pockets through which water can pass into the substrate rather than running off or pooling on the surface.

Permeable concrete looks and behaves much like other concrete surfaces, and is appropriate for driving and parking areas. With the improved drainage, permeable paving can require less ice build up and salting.

GRASS PAVERS

GRASS PAVER systems are forms of pervious paving that allows grass to grow within the paving matrix. There are many different types of grass paving systems with various degrees of grass coverage. Grass pavers are designed to accommodate parking loads and light traffic.

A grass paving system could be easily installed in overflow parking areas at the edges of the parking lot that are typically used only during peak shopping times. The benefits of using this type of paving in areas with good infiltration that are only needed periodically is that they allow for water infiltration, reduce urban heat island effect from excessive hardscapes, and replace concrete with a grassy texture.

WATER TOOLKIT

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• Permeable pavers	●	
• Grass pavers	●	
BUILDING:		
• Green roofs	○	●
• Rain water harvesting	●	●
• Non-potable reuse	○	●
• Low flow fixtures		●
WASTEWATER:		
• Living Machines	○	●

GREEN ROOF

A ***GREEN ROOF*** system is an extension of the existing roof which involves a high quality water proofing and root repellent system, a drainage system, filter cloth, a lightweight growing medium and plants. Green roof systems may be modular, with drainage layers, filter cloth, growing media and plants already prepared in movable, often interlocking grids, or loose laid where each component is installed separately.

Green roof systems are categorized as intensive or extensive depending on the type of system and intended use. These systems range in depth from a few inches to several feet deep, and can prolong the life of roof membranes.

Green roofs reduce building stormwater runoff. When combined with rainwater harvesting, green roofs can be used to filter sediment from harvested rainwater.

RAINWATER HARVESTING

RAINWATER HARVESTING from building rooftops takes advantage of rooftop drainage and reduces stormwater runoff from buildings.

Building rooftops behave similarly to other impervious surfaces when it comes to stormwater, but are typically much less dirty than paved driving surfaces. Because rooftops are less polluted, stormwater that falls on rooftops is typically safe for reuse in non-potable applications (such as irrigation and toilet flushing) with minimal cleaning. Water can be easily harvested by collecting roof runoff at downspouts.

Rainwater harvesting can accomplished in a manner that either hides or expresses the collection of water. Opportunities to express water collection and movement can be sculptural or playful, and can be very educational.

WATER TOOLKIT

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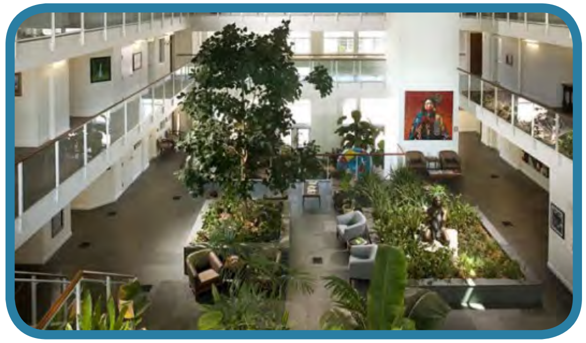
• Low flow fixtures		●
WASTEWATER:		
• Living Machines	○	●

LOW-FLOW FIXTURES

LOW-FLOW FIXTURES are plumbing fixtures that reduce the consumption of potable water at the source. Low-flow faucets and shower heads reduce the flow rate of water without loosing water pressure. Dual-Flush toilets are designed to adjust the amount of water used each flush without reducing performance. Use of low-flow fixtures can easily reduce potable water use by 30%

Water conservation is perhaps the simplest, most economical and most important goal for future building development. The success of low-flow fixtures is that they do not require behavioral changes of the people using them. The success of other water conservation strategies, such as water harvesting or recycling on site will be greatly increased by making water conservation a first priority.

LIVING MACHINES



A ***LIVING MACHINE*** is a hybridized wetland wastewater treatment system developed by Worrell Water Technologies. These systems rely on plants and microorganisms to extract nutrients, minerals, impurities and bacteria from grey and black water.

Through an intense bioremediation process, water that passes through the system is cleaned to a high level, making it safe for reuse in non-potable uses (irrigation, toilet flushing, building cooling, fountains etc.) Water is processed through a series of subsurface tanks. These systems do not require the chemicals or high energy required by traditional wastewater treatment systems. Living Machines can be designed to treat black and gray water from a building or larger district.

Living Machines can be installed in atrium gardens or greenhouses. What is visible of the process is the lush plant life supporting the hidden bioremediation process. These are safe, odorless, and highly effective.

WATER TOOLKIT

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