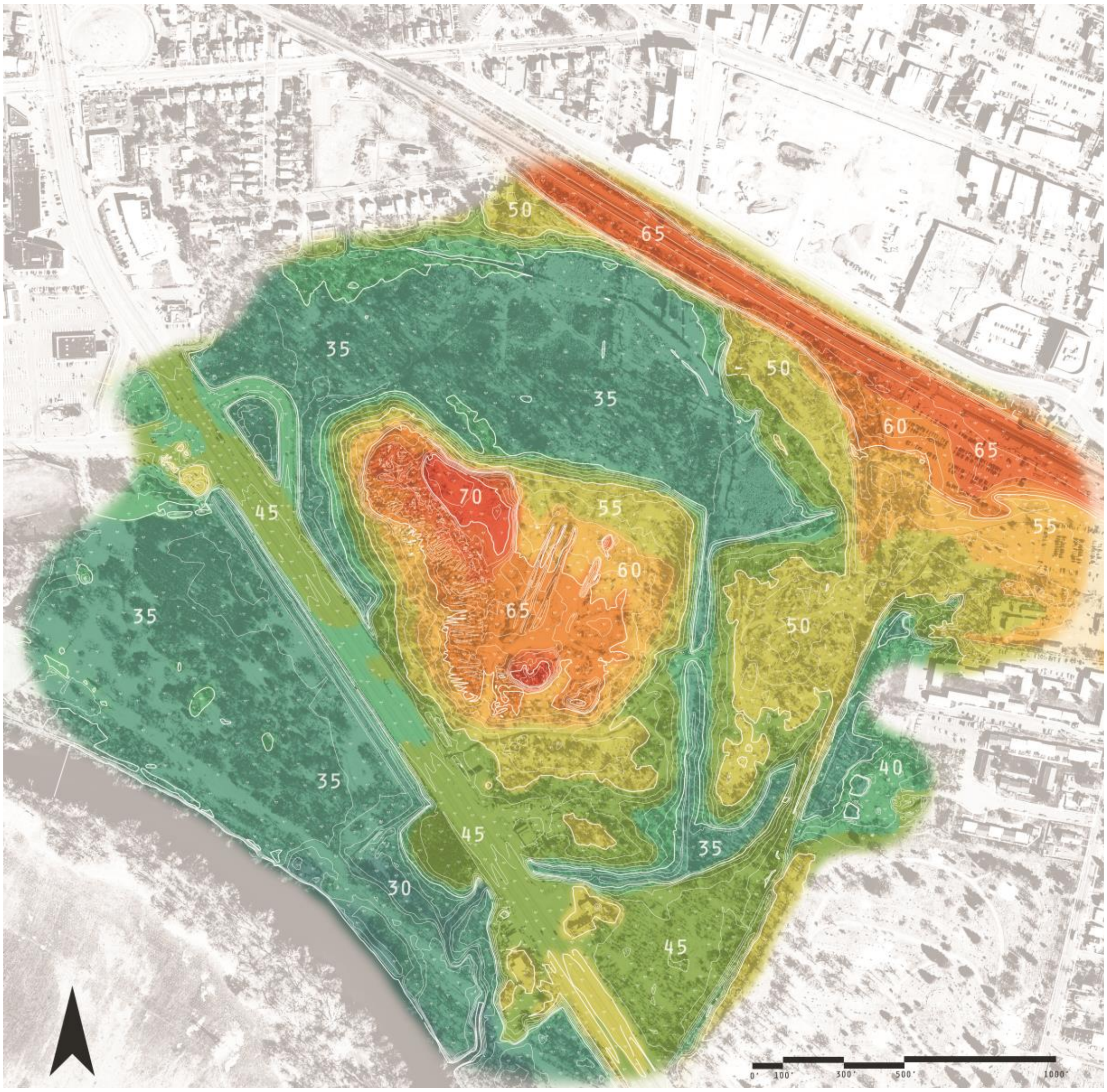
Somerville Station Area and Landfill Redevelopment

Green Seam & Wetland Conceptual Restoration Design Plan



Project Overview

CUES
Center for Urban Environmental Sustainability

Located adjacent to the Somerville, NJ Transit station,
a former municipal landfill operated between 1954 and 1984. In 1998 the site was designated an ***Area in Need of Redevelopment***. The community's ***Redevelopment Plan for the Borough of Somerville Station Area and Adjacent Landfill*** was completed in 2007. This Plan details a number of objectives for the redevelopment including new housing options, support for economic development, and pedestrian connections between the redeveloped areas, the Somerville downtown commercial district, and the NJ Transit train station.

Objective Twelve of the Redevelopment Plan is to "***provide a network of open spaces for Somerville residents, connecting active and passive recreation areas between the Raritan River and the downtown core, including existing community resources such as the Peter's Brook Greenway and the Old Dutch Parsonage***." This open space portion of the Redevelopment Plan has been named the "Green Seam" - the corridor of open space that will connect the proposed "Hub" (high density mixed use commercial land use) and the "Heights" (moderate density town houses, low rise apartments, and office land uses), with the existing commercial downtown businesses.

Designing the Green Seam presents significant challenges and opportunities:

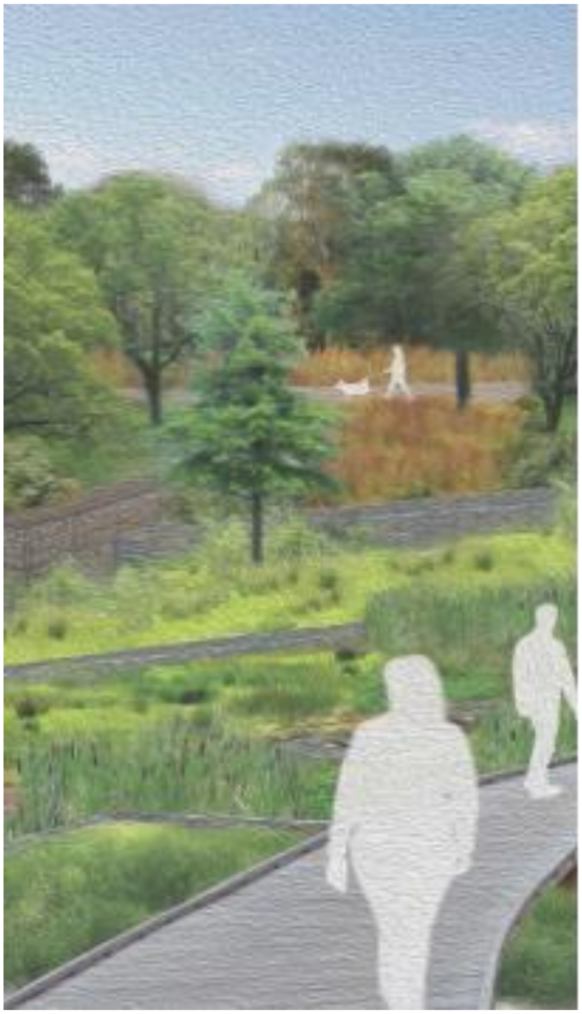
1. The site is adjacent to a large transportation network that includes rail, car, and water amenities;

2. The landscape has had many topographic, soil, and vegetation alterations due to human activities, including the landfill operation and transportation entities;
3. Portions of the proposed redevelopment (including the Green Seam stream bed) will be covered by an impervious cap, which will preclude natural exchanges between surface and ground waters;
4. Contaminated ground water will be pumped, treated, and returned to the surface wetland system – details of this treatment system are not yet finalized;
5. Redevelopment and the addition of multiple impervious surfaces (including a proposed roadway connecting Rt. 206 with the train station complex) require management of storm water that will be generated from the development in compliance with New Jersey storm water regulations;
6. The site contains at least three identified wetlands in northern and southern sections and the land between Route 206 adjacent to the Raritan River; and
7. Portions of the redevelopment area lie within the 100 Year Flood Plain.

The Conceptual Design for the Green Seam must enhance natural features onsite while addressing the 'non-natural' existing site characteristics, treat storm waters that will be generated by the redevelopment, take into account the potential for flooding, and connect the Green Seam to the multiple adjoining land uses.

To provide an extensive review of existing conditions and develop design options for the Borough of Somerville to consider, the Somerville Train Station Redevelopment and Green Seam was the topic for a Rutgers Landscape Architecture Studio Design Course during the spring 2014 semester. Upon completion of the studio, the students presented design concepts to the Somerville Mayor and Council. Based upon comments made at this public meeting and additional direction from Colin Driver, the Borough of Somerville representative, final Conceptual Design options for the Green Seam, with particular focus on the wetlands, storm water management, and connections to other Somerville amenities and redeveloped areas were explored.

Project Phase One: Spring 2014 Undergraduate Design Studio

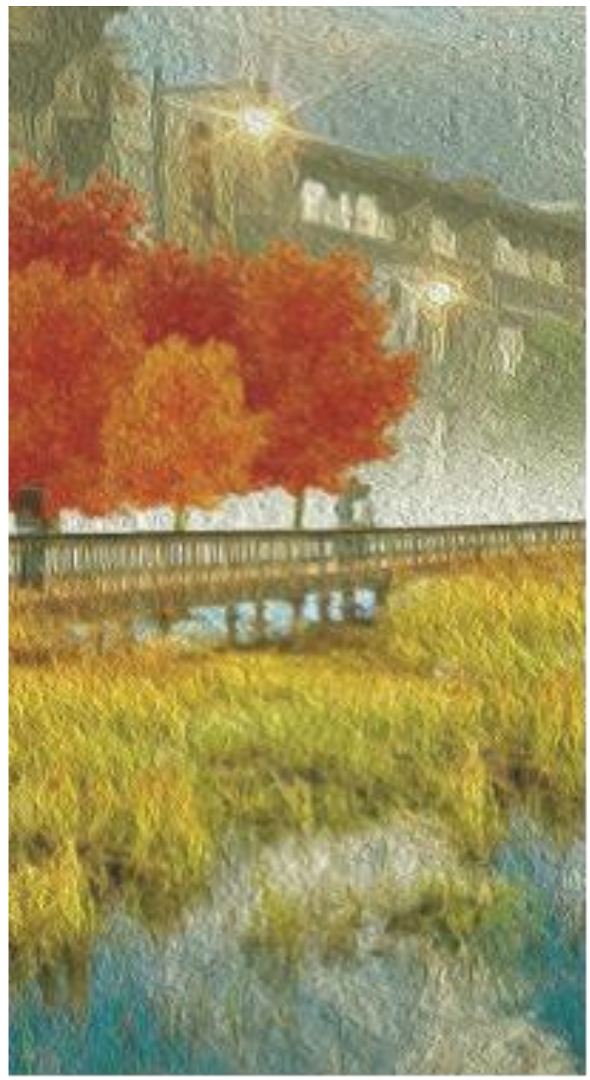


Wetland restoration and the concept of ecosystem services have become the cornerstones of environmental remediation and enhancement efforts. However, the success of such initiatives, and the metrics used to evaluate them, can be controversial, especially within the urban context. The Spring 2014 Landscape Architecture Design Studio explored the potential for creating wetlands and upland open space within the disturbed landscape of an urban Brownfield, the Somerville "Green Seam". Students examined the hydrologic, ecological, and social parameters of possible remediation and reuse efforts. In addition, they explored the issues of valuing ecosystem services, as well as the questions of what constitutes "nature," and the role of open space conservation and function within (sub)urban areas. At the crux of the design challenge is the need to balance and prioritize both social and ecological functions associated with the wetlands and green space within an urban context, while meeting the needs of local residents, regulatory agencies, and redevelopment participants.

Deliverables: The studio produced an analysis of existing conditions and a range of conceptual alternative designs for the Green Seam Wetlands. The students conducted numerous visits to the site and participated in directed interviews with the engineering professionals and Somervile representatives who participated in development of the original conceptual restoration plans. Representatives of the community, engineering professionals and representatives of the New Jersey Department of Environmental Protection (NJDEP) participated in both the mid-term and final student design presentations at Rutgers

University. The design concepts produced in this studio were presented to the Somerville Mayor & Council at the May 19, 2014 meeting. Their reaction to the concept of creating a water feature that provided a ‘gateway’ to the Green Seam was especially positive.

Project Phase Two: Integration and Evolution of Conceptual Designs



Based on community feedback to the studio Green Seam designs, the CUES team composed of Drs. Gallagher, Ravit, other Rutgers faculty members, and selected students, refined and evolved the student design elements into a final Conceptual Design for the Green Seam, with particular focus on the wetland areas and stormwater management.

To support the development of construction documents for the Green Seam conceptual plan, the students verified field conditions and confirmed hydrologic models to ensure integration with the site’s existing conditions. A site plan showing proposed design features and elevations relative to the surrounding community was developed. The elevation plan depicts both existing and proposed elevations. Cross-sections, portraying accurate vertical scale were prepared. A vegetative assemblage and planting plan integrated to the proposed site hydrology was developed for the Green Seam. Rough cost estimates, based upon both proposed materials and prevailing regional labor rates are included as part of this phase of the project. At the direction of the Borough of Somerville, CUES may also conduct an online survey or hold public meetings to obtain additional community input and comment.

Deliverables: A Conceptual Landscape design for the Green Seam with specific emphasis on wetlands and storm water management, including an analysis of the hydrologic budget for the proposed wetlands, as well as cost estimates, including both hardscape and vegetative elements, for the proposed design for the Green Seam project.

Hydrologic Existing Conditions, Assumptions and Models, Proposed Hydrology

To support design of planting plans based on proposed hydrologic changes to the Somerville Green Seam, a hydraulic and hydrologic (H&H) model was developed using the USEPA Storm Water Management Model (SWMM) 5.1 software to represent the site's existing and proposed conditions. The conceptual framework for the SWMM model was initially defined in ESRI ArcMap via the delineation of H&H features so the future model would be geospatially accurate. The same data also underlies the other geospatial analysis efforts of this project.

GIS Delineation of Features

In order to effectively model the unnamed tributary passing through the Somerville, NJ Landfill site using EPA SWMM 5.1 modeling software, the discrete hydraulic and hydrologic features were first conceptually defined in ArcMap.

- A variety of data sources were explored prior to the modeling process including:
    - ESRI Web Imagery Service (land-satellite. terrain imagery)
    - ESRI Web Topographic Service (simplified topographic imagery)
    - NJDEP HUC-14 boundaries [Hydrologic Unit Codes delineate progressively smaller watersheds. HUC-14 data presents the smallest subwatersheds delineated thus far.
    - NJDEP Land Use Land Cover (LULC) data
    - NJDEP municipal boundaries
    - NJDEP state rivers data

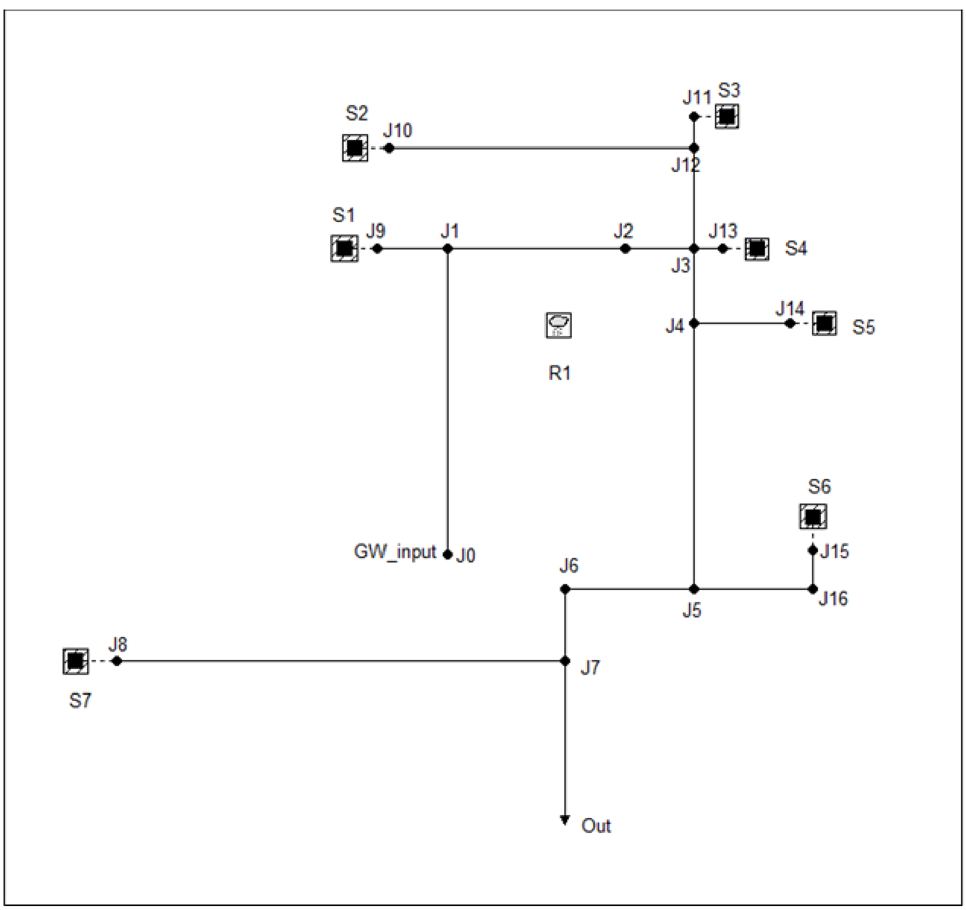
    - NJDEP state roads data
    - NJDEP Watershed Management Area (WMA) Digital Elevation Model (DEM) data
    - NJDEP wetlands data
- Additional data sources were considered during the modeling process including:
    - [Online Topo Source] QUADS Map of Raritan-Somerville area
    - Geosyntec Brownfield Development Area (BDA) Initiative Boundary Map
    - Geosyntec Existing Topographic Conditions [Modified by Ryan Goodstein]
    - Geosyntec HEC-RAS Modeling Map [Appx 10A – HEC-RAS output.pdf]
    - NJDEP soils data [soilmu_a_nj035]
    - Tax Map of the Borough of Somerville, Somerset County, New Jersey
- The unnamed tributary was outlined at a scale of 1:4000 based on the ESRI Web Topographic Service. This data file is the "Unnamed Tributary" layer.
- The watershed area flowing into the site was determined using the HUC-14 boundaries, the Raritan River boundary, and a linear interpolation of the DEM, topographic, and QUADs data. This data file is the "Flow Area" layer.
- Subcatchment boundaries were delineated using a linear interpolation of the existing topographic conditions and DEM. This data file is the "Subcatch lines" layer.
- Subcatchments are shown in ArcMap as polygons fit to the subcatchment boundaries. This data file is the "Subcatchments" layer.
- The "Subcatchments" layer was later altered to reflect contributing subcatchments (green) and noncontributing subcatchments (pink).
- The "Subcatchments" layer was cut into polygons reflecting known impervious areas based on the Web Imagery Service data. Impervious surfaces are designated in pink; pervious surfaces are designated in green. This data file is the "impervious" layer.
- The existing topographic conditions data ("existing topo" layer) has been edited multiple times. The most accurate version of this data in ArcMap is the "existing topo rectified" layer. This data has been georeferenced to the ESRI Web Imagery Service and is accurate with $\leq$ 1% error or 10 feet uncertainty at the fringes of the map. Overall, the topo is well-matched to the imagery.

- The HEC-RAS Model map has been georeferenced to both the web imagery and the existing topographic conditions. When the data is georeferenced to the ESRI Web Imagery Service it agrees well with the unnamed tributary, but not with existing topographic conditions. When the data is georeferenced (or warped) to the Geosyntec existing conditions it agrees well with them, but does not agree with the unnamed tributary, subcatchments, or ESRI web service imagery.

The SWMM model was developed using Geosyntec's HEC-RAS Model Map, the subcatchment layers, and the "UnnamedTributary" layer.

SWMM Modeling

SWMM models discrete H&H features in waterways and relies extensively on user-defined input. The hydrologic features modeled in SWMM for this site include the subcatchments and a hypothetical rain gage that is used to model rainfall over the site. The hydraulic features modeled in SWMM for this site include many nodes (mainly junctions in the tributary, but also an outfall and storage unit), links (mainly conduits, but also a weir), and transects (which define the cross sections of the tributary).



SWMM Model Schematic of water in flows and outflows to surface water wetlands and stream (Green Seam).

Hydrology - Subcatchments

- There are 15 subcatchments represented in SWMM. Each subcatchment empties into a starting junction of a conduit, and each subcatchment is numbered in reference to that junction.
- The subcatchments are numbered S0, S1, S10, S11, S12, S13, S14, S15, S2, S3, S4, S5, S6, S7, S8, S9-1, and S9-2.
- All subcatchment data in SWMM is based on existing GIS data.
- Subcatchments have a number of properties. The most significant properties edited for modeling include: Rain Gage, Outlet, Area, Width, and % Imperv.
- The % slope and roughness of the impervious (N-Imperv) and pervious (N-perv) surfaces should also be modeled if possible.

Hydrology - Rain Gauge

There is only 1 rain gauge in the SWMM model. The rain gauge is used to distribute rainfall to the subcatchments in SWMM. The rain gauge accepts rainfall data as rainfall intensity, rainfall volume, or cumulative rainfall and this data must be in the form of time series. Times series are discrete data series that provide numerical data in time steps, which look like histograms when graphed. For the purposes of our model in SWMM, rainfall intensity time series were used to model storm events. Several design storms were converted to rainfall intensity time series including the 2-yr, 10-yr, 25-yr, 50-yr, and 100-yr design storms for Somerset County New Jersey and a hypothetical 500-yr storm.

Hydraulics - Nodes – Junctions, Outfalls, Storage Units

- There are 29 junctions represented in the SWMM model. Junctions are points where conduits begin, differentiate, or merge. Junctions accept runoff from subcatchments and conduits.

- The junctions are numbered J0, J1, J10, J11-1, J11-2, J11-3, J12, J13-1, J13-2, J13-3, J13-4, J13-5, J13-6, J14, J15, J2, J3-1, J3-2, J3-3, J3-4, J3-5, J4, J5, J6, J7, J8, J9-1, J9-2, and J9-3.
- All junction data in SWMM is based on existing GIS data and Geosyntec's HEC-RAS or topo data.
- Junctions have a number of properties. The most significant properties edited for modeling include inflows and invert elevation. Only one junction (J0) in the model has an inflow, this inflow is the partially-treated groundwater pumped to the treatment wetlands.
- All nodes have invert elevations. The invert elevation is the elevation of the bottom of the stream channel being modeled at the junction. Invert elevation is used to specify the gradient of a stream channel's profile.
- There is 1 outfall represented in the SWMM model, denoted by "Out." This outfall is where the unnamed tributary meets the Raritan River. The outfall's properties have not been edited, since this object was not the focus of the model.
- There is also 1 storage unit represented in the SWMM model, denoted by "Storage." This storage unit currently serves as a place marker in the model for a future water feature placed at the northern end of the tributary's main channel. The only property of the storage unit that was edited was the invert elevation which is set at 36' based on Geosyntec's HEC-RAS modeling data.

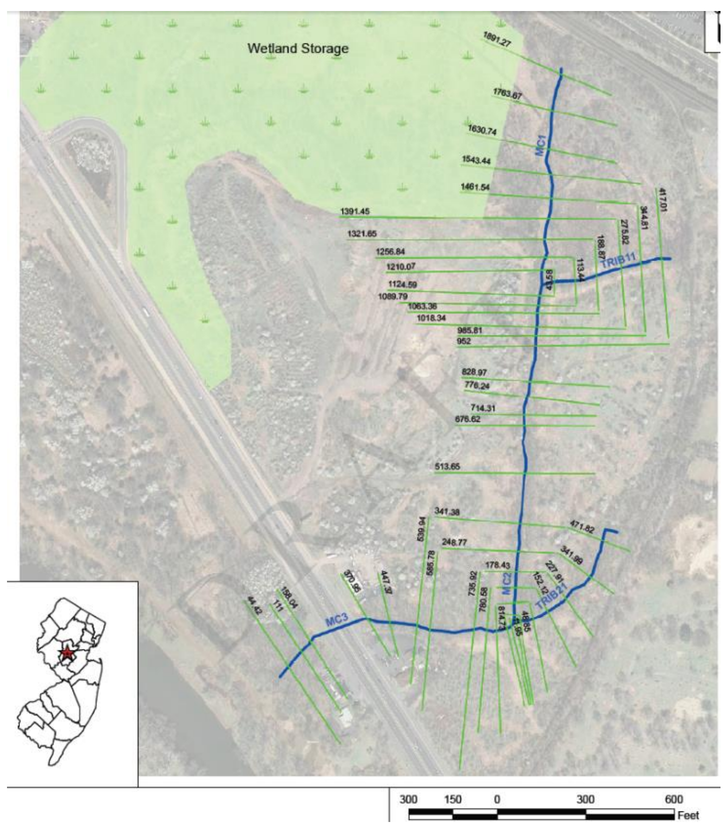
Hydraulics - Links – Conduits and Weirs

- There are 28 conduits represented in the SWMM model. Conduits are clearly defined stream channels with defined inlets and outlets that direct runoff.
- The conduits are numbered C0, C1, C11-1, C11-2, C11-3, C12, C13-1, C13-2, C13-3, C13-4, C13-5, C13-6, C14, C15, C2, C3-1, C3-2, C3-3, C3-4, C3-5, C4, C5, C6, C7, C8, C9-1, C9-2, and C9-3.
- All conduit data in SWMM is based on existing GIS data and Geosyntec's HEC-RAS data.
- Conduits have a number of properties. The most significant conduit properties edited for modeling include shape, maximum depth, length, and roughness.

- A conduit's shape refers to the geometry of a conduit's cross section. Several conduits have been modeled using transects based on Geosyntec's HEC-RAS modeling data. Other conduits utilize standard conduit geometry for simplicity.
- A conduit's maximum depth is the maximum depth of its cross section or transect.
- Each conduit's length has been estimated using GIS data and HEC-RAS.
- A conduit's roughness refers to its Manning's roughness coefficient, which is an empirical coefficient describing the friction water encounters along an open channel flow path.
- There is 1 weir represented in the SWMM model, denoted by "W1." This weir directs water out of the hypothetical water feature / storage unit and back into the main channel. The weir's properties have not been edited. A v-notch weir has been suggested.

Hydraulics – Transects

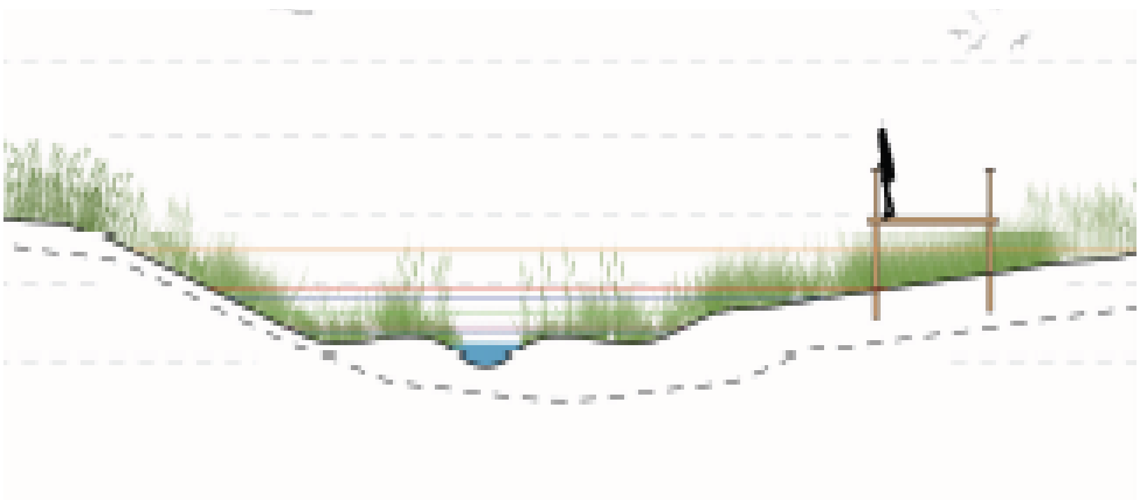
- There are transects represented in the SWMM model. Transects are graphically defined cross-sections of stream channels. Transects are commonly designated by [river] station, the distance upstream of a stream channel's outlet or end. The transects are numbered T2, T3, T10, T11-1, T11-2, T11-3, T3-1, T3-2, T3-3, T3-4, T3-5, T13-1, T13-2, T13-3, T13-4, T13-5, and T13-6. Transects T2 and T3 are not currently in use in the model.
- Transects are defined by [cross-section] stations and elevations; right bank, left bank, and channel roughness; bank stations; and modifiers (if needed).



NEW JERSEY 24 HOUR RAINFALL FREQUENCY DATA
Rainfall amounts in Inches

County	1 year	2 year	5 year	10 year	25 year	50 year	100 year
Somerset	2.8	3.3	4.3	5.0	6.2	7.2	8.2

USDA Natural Resources Conservation Service 220 Davidson Ave., Somerset, NJ 08873
New Jersey State Office Tel. 732-537-6040 Fax 732-537-6095
NJ Supplement Exhibit 2 NJ 2 September 2004



Hydrologic Modeling Disclaimer

The hydrologic models were run using the best data available to Rutgers CUES during summer, 2014. Therefore, the accuracy of this research is limited to the accuracy of that data. Additional analyses will be required to complete final engineering plans for the Green Seam, such as onsite measurements, data review, and field verification. This document alone was created as a support for the conceptual landscape architectural design proposals.

Green Seam Design Approach & Solutions

The Design Process

A broad-based, goal-driven approach was used to develop the proposed conceptual design. The planning process stressed the fundamental relationship between ecological resource significance and community development needs. The planning process encouraged feedback through meetings and presentations to the Borough of Somerville Council, Borough planning officials, and regulatory personnel from the New Jersey Department of Environmental Protection. Importantly, the planning process resulted in documentation of planning efforts that built a consensus among participants, assured logic and consistency in the proposal, and provide a valid rationale in decision-making. The planning team first considered the existing redevelopment plan, which had been labeled the "Consensus Plan". The team then considered alternatives that could maximize the ecological functions and values of the site, while meeting the goal of connecting the train station to Route 206. Finally, a compromise plan was developed that maximized, to the greatest extent possible, both the ecological attributes of the site and the need for redevelopment.

Statements of Significance

The design documentation presented in this study, while conceptual in nature, proposes specific interventions that address several critical issues:

- The need to create a "place" in which Somerville residents have an opportunity to be aware of, and to experience, the natural resources of the site within its historical context. This goal is addressed through walkways and multiple site entrances which connect with existing Somerville amenities.

- Second, the isolation of the site created by being adjacent to Rt. 206 and the Raritan Valley line of the NJ Transit rail system, needs to be mitigated by strong connection points to the Green Seam. The concept of crossroads, connections, and entrances is integral into the design concept.
- Lastly, ecological enhancements could not only serve to improve wetland habitat values, but also alter the site's hydrologic character, reducing peak flow rates and providing water storage, thereby mitigating potential flooding and erosion damage caused by severe storm events.

Creating Place

"The catalyst that converts any physical location - any environment if you will - into place, is the process of experiencing deeply"[1]. Most transit communities are designed around the concept of efficiently and rapidly moving people into and out of a specific space. This goal often results in designs that are not pedestrian or neighborhood friendly, and can result in communities that become dissected, both physically and socially. The preferred alternative presented here fosters a sense of place by connecting the community to the surrounding ecologic environment both visually and physically. Such connections allow for the type of experience that fosters a sense of place, a prerequisite for the development of a land ethic and the practice of sustainability. This approach will enhance a sense of community, making the Green Seam a valuable socio-economic amenity for the Borough of Somerville.

[1] Allan Gussow

Crossroads and Connections

Intersecting paths both physically and culturally have always been a strong characteristic of the State of New Jersey and the Somerville area in particular. Many endemic tribes would cross paths in their search for food and shelter. As a state bordered by the Atlantic Ocean, the Hudson River and the Delaware River, New Jersey has served as a point of egress for both immigrants and goods for the entire country. Exact times of change that marked the turning points in various battles and wars later gave rise to significant historical events. In addition, the changing economic conditions lead to the construction of canals, railroads and highways, all with adjacencies and influence on the study site. New Jersey's geographic location between two historically and economically significant cities, New York and Philadelphia, and Somerville sitting at the midpoint of that connection, has foster a an additional importance of “place“ to the borough. The proposed conceptual design solution for the project is sensitive to these attributes in its overall site plan.

Design Interventions

Connecting the Community and the Wetlands: Providing access to water bodies and other natural resources, a right embodied in the Public Trust Doctrine, has become an increasingly difficult as population densities have increased. Cognizant of this issue the design team sought to facilitate the appreciation of the existing natural resources with both pedestrian access and vistas, Road Orientation: The balance between a communities infrastructural requirements and its "sense of place" is a long standing controversy within planning and design field. Nowhere was this more evidenced than in New York City where under the direction of Robert Mosses 13 bridges and 416 miles of highways were constructed during 1940's and 50's. Such provisions for automobiles also discounted the people of Manhattan from most of the

waterfront, and displaced thousands of lower income people. The placement of the road connecting Rt. 206 with the Somerville Train Station was given much consideration. The design team felt strongly that the existing redevelopment plan created a disconnect between the community and the resources that would negatively impact the residents quality of life. The team also considered a "no road" alternative which obviously did not address current and future traffic problems. A third alternative has therefore been proposed which basically repositions the road towards the edge of the proposed development. This alternative allows for a direct nexus between residential development and natural resources.

Terraces: The creation of terraces provide a novel approach to the redevelopment of landfills. Terraces will allow for trees and other woody vegetation to be planted on top of the

liner, instead of the herbaceous plantings typically mandated by liner systems. The terraces are separated from the liner by a special secondary liner that will provide extra protection. With this terrace system Somerville has the opportunity to set a new precedent for landfill reuse.

Ecological Enhancements

Sometime during 2008 an unprecedented global demographic transition occurred, the majority of us now live in cities[2]. This fundamental demographic transition will undoubtedly change who we are and how we experience and understand natural systems. The expansion of urban areas is economically driven[3] and likely to include at least 80 percent of the North American population by 2050[4]. Urban centers in the US are highly industrialized places, expanding at a rapid pace with little to no green space remaining. Brownfields are mostly found in urban areas and were formerly used for industrial purposes and later abandoned. Undeveloped Brownfield properties do not generate tax revenue; they may be an eyesore to the surrounding area and are generally contaminated, thus posing a health and an environmental threat[5]. The proposed redevelopment of the Somerville Station Landfill area represents an opportunity to explore not only the potential for commercial and residential

[2] Flavin C, in (2007) State of the World, Our Urban Future, A World Watch Institute Report on Progress Toward a Sustainable Society. W. W. Norton & Company New York, pg 3

[3] Krugman P (1999) The role of geography in development. *International Regional Science Review* **22** (2), 142-161.

[4] United Nation Population Fund (2007) State of the world population 2007. *United Nations* 118 p.

[5] Lesage P, Ekvall T, Deschenes L, Samson R (2007) Environmental assessment of Brownfield Rehabilitation Using two Different Life Cycle Inventory Models. Part 1: Methodological Approach. *International Journal of Life Cycle Assessment* **12**(6) 392-298.

redevelopment of a former industrial site, but also the restoration and enhancement of the site's remaining wetlands.

Freshwater Wetlands Enhancements: Epitomizing the paradigm shift that has occurred over the past several decades this project attempts to enhance/restore function to a wetland which has been impacted by use as a landfill. Wetland restoration and the concept of "no net loss" has been the cornerstone of efforts towards environmental remediation/enhancement since its inception as federal policy in 1989. The design of the Green Seam provides for the replacement in-kind, of palustrine wetlands through the use of a series of terraces. In addition, the plan enhances ecological function through the replacement of areas dominated by invasive spices with higher diversity native assemblages.

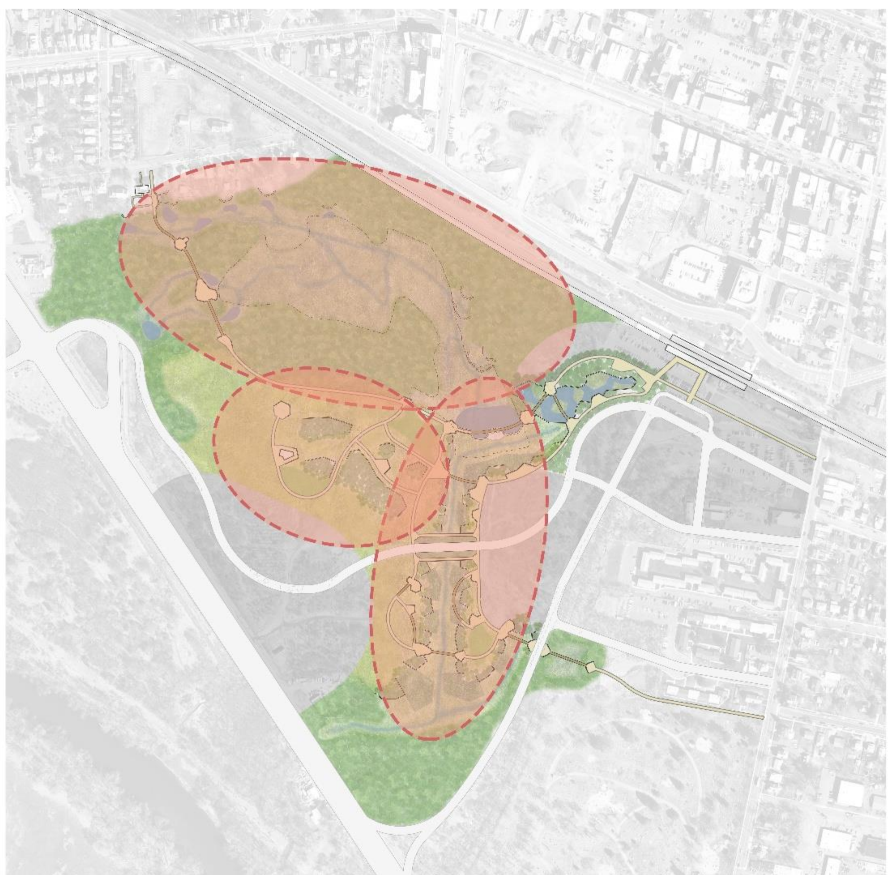
Upland Restoration/Conservation: Grasses and species of trees typical of early succession currently dominate the landfill site.   It may be possible within several of these areas to create a cross section of the vegetative communities, which represent the new novel communities of urban areas. The creation of a mosaic of vegetative communities that transition from wetland to upland forest would provide for an exceptional study of habitat restoration in the urban environment while enriching the visitor/resident experience. The proposed compromise plan attempts to maintain as much of the site, given projected development needs in contiguous upland open space.

Changing hydrology: Due to anthropogenic forcing (i.e. filling and the addition of hardscape) and the separation of ground water and surface water, the existing system has become increasingly "flashy" exhibiting a significant loss of retention within the watershed and particularly within the landfill site itself. Therefore several design interventions have been proposed to enhance retention. Wetland improvements include the deepening of several wetland areas to enhance water storage and create standing water habitat. These enhanced wetlands also include forbay areas to capture sediment thereby facilitating maintenance. In addition new wetland areas are integrated into the developed areas to trap and slow stormwater runoff. Finally, the proposed system of terraces will allow for the capture of stormwater during specific storm events and the retention of that water on site for longer periods of time.

Phasing

Should the proposed conceptual plan updates be implemented, three (3) distinct phases of construction are plausible:

1) Green Seam capping and terrace construction;
2) Groundwater treatment infrastructure and wetland construction;
3) Open meadow and terracing of site interior.



Conclusions, Recommendations, Caveats

Ten years have elapsed since the original compromise reuse plan was developed. In this time period a number of original assumptions, especially with respect to flooding and the need for publically accessible open space have evolved. Therefore, we strongly recommend using the results of this study to update the reuse plan in light of recent flooding and storm events, as well as actual approved redevelopment, which is now higher density than the original plan on the station side of the site. The ability to retain more open space, an attractive riparian vista, and wetlands to treat impervious surface storm water flows can now be envisioned without an accompanying reduction in the ratable tax base.

APPENDICES