Methodology to a Watershed Based Approach to Clean Water and Natural Resource Management

Part I

Landscape Characterization

PART I. LANDSCAPE CHARACTERIZATION

The Approach

The goal of this methodology is to provide a scientific approach to analyzing the ecological processes and natural resources that maintain a functioning watershed, and to identify how anthropogenic activity has impacted those processes and responses. The first step characterized the effects of anthropogenic land use on physical processes and biological elements within the study area. The five physical processes and two biological elements focused on in this work are listed below.

Physical processes:

- Delivery and routing of water
- Delivery and routing of sediment
- Delivery and routing of large wood
- Delivery and routing of nutrients/toxicants/bacteria
- Delivery and routing of heat

Biological elements:

- Upland habitat connectivity

Thurston County staffs acknowledge that the Methods are complex, and not very readable to the non-scientific audience. However, the Methods are a documentation of how Thurston County completed the watershed characterization work. That was possible based on the fact that Thurston County staff have the education and experience to complete the analysis. Because of the education and experience Thurston County was able to "automate" the GIS process,

Step 1. Establish Spatial Scales of Analysis

The alteration of these core processes and elements (or "pathways") by human activities results in a change in how a site functions. These processes and elements operate over large spatial and temporal scales and have typically not been assessed when evaluating site specific natural resource restoration activities. Watershed characterizations evaluate the potential restoration success in the context of its location on the landscape.

Step 1A. Establish Drainage Analysis Units

Drainage analysis units (DAU)s were developed based on the needs of the study. Table 1 provided guidance on the minimize size of the DAU. The particular unit selected was 0.25 square miles, as an average. This unit was based upon guidance published by the Center for Watershed Protection (See Table 1) in determining sizing for activities related to stormwater management. This scale was used because one of the main focuses of this study was to restore hydrologic function using natural resource sites (wetlands, riparian, and floodplains).

Purpose

The DAU establishes the scale at which subsequent data is generated and processed to develop the study area. Using the DAU scale allows for the potential to assess direct impacts and cumulative impacts of existing and future land uses and to assess and address storm water impacts on an individual stream basis.

Methods

To carry out this step, Thurston County completed a spatial unit of analysis delineation using 2002 LiDAR data using ARC-HYDRO.

1. Acquired topographic data of the study area from a digital elevation model (DEM).
2. Established scale for assessment and planning needs. This scale was established using published guidance from the Center for Watershed Protection.
3. Used automated processes to create and edit 2002 DEM.
4. Developed drainage boundaries for DAU's from DEM.
5. Develop study area from the aggregation of the DAUs.

Table 1: Description of typical terms and areas of Watershed Management Units used by Thurston County to establish consistent scale for assessment and planning needs.

Watershed Management Unit	Typical Area (square miles)	Influence of Impervious Cover	Sample Management Measures
Catchment (Drainage Analysis Unit (DAU))	0.05 to 0.5 32 to 320 acres	very strong	stormwater management and site design
Sub-watershed	0.5 to 30 320 to 19,200 acres	strong	stream classification and management
Watershed	30 to 100 19,200 to 320,000	moderate	watershed-based zoning
Sub-basin	100 to 1,000	weak	basin planning
Basin	1,000 to 10,000	very weak	basin planning

Zielinski, Center for Watershed Protection, 2002

Data Needs

1. Previously defined project area boundary
2. DEM data
3. Depending on the purpose and scale of the study. Stormwater infrastructure data will be required when designing projects at a site scale.

Product

Thurston County produced a GIS data layer of DAU, sub-watershed, and watershed boundaries that defined the study areas.

Step 1B. Establish Study Area

Definition

A study area is normally identified by a wide range of social, political, or regulatory factors. Once known, it needs to be expanded or clipped to align with watershed boundaries. The Totten, Eld, and Deschutes watersheds all drain to South Puget Sound. These watersheds were prioritized based on local, state, and federal protection efforts to reduce any further degradation to Puget Sound.

Purpose

To obtain or create a spatial layer that specifies the boundaries of the study area, such that the land area draining to any point or waterbody of interest is included within the study area.

Methods

The study areas for Totten and Eld Inlets and Deschutes were established through a GIS process of displaying the area of interest and refining the final boundary with updated topographic data.

Data Needs

An existing watershed or sub-watershed boundaries data layer, or a digital elevation model from which boundaries can be delineated. .

Product

A GIS data layer of the Totten, Eld, and the Deschutes study areas.

Step 2. Establish Temporal Scales of Analysis

Understanding present and potential future watershed conditions requires multiple periods of assessment. Pre-

Base data for determining DAU geography consisted of a LiDAR derived bare earth digital elevation model (DEM). The bare earth DEM was processed from point cloud data acquired from a leaf-off LiDAR mission in February 2002 under the management of the Puget Sound LiDAR Consortium (PSLC). PSLC has determined that this data is applicable for hydrologic modeling at the horizontal scale of 1:12,000 or smaller, with vertical accuracy on the order of a foot.[1]

The bare earth DEM product was further processed to remove imperfections by removing and filling sinks through an iterative process. This process utilized Arc Hydro Tools 9, an available extension for ArcGIS 9. The hydrologically corrected DEM yielded the DAU delineations for further automated and manual refinement. This refinement included clipping out DAU's which were outside the specific project boundary, aggregating smaller units which were well below the 0.25 average sizing threshold, and manually editing anomalous drainage flows not removed from automated post processing procedures.

development and current land use conditions are needed to infer past changes and cumulative impacts. Current and future build-out conditions are needed to understand potential future cumulative impacts in a build-out scenario and assess the potential for the watershed to maintain its essential ecosystem processes and functions over time. In the current watershed characterization work completed by Thurston County, future landcover conditions were not assessed because designated zoning and actual build out conditions are not equal.

Step 2A. Create a Pre-Development Data Layer

Purpose

A pre-development land use data layer is the reference point for assessing the current and future states of natural resources. In turn, an assessment of landscape condition requires an understanding of the extent of change in ecological processes from a pre-development to present and future land use conditions.

Methods

Thurston County used available General Lands Office GIS data to characterize the pre-development vegetation and natural resources of the study area.

Data Needs

Pre-development vegetation and natural resource data for the study area.

Product

A GIS data layer of pre-development landcover.

Step 2B. Select or Create a Current Landcover Data layer

Purpose

This project's landcover classification scheme was devised for the purpose of establishing an ecologically functioning relationship between the built and natural environments, specifically, through the development of indicators relevant in determining the impact to physical and biological indicators in the project area.

Current landcover data are used in two ways. First, this data set is used with the pre-development data layer to characterize the extent of change in landcover. Second, this data layer is used to calculate quantitative values of landcover types for use in key landscape indicators, which are used to represent the extent of alteration in the five ecological processes.

Total Impervious Area (TIA) and vegetation cover is used in watershed characterization to describe the degree of hydrologic alteration within drainage basins. TIA is defined as the percentage of land within an area that is impervious to water, and includes rooftops, paved surfaces, and compacted earth. TIA is derived from land use or landcover data, and is a key indicator of ecological condition.

NOTE: Effective impervious area (EIA) is a better indicator of hydrologic alteration, because it characterizes the impervious area directly connected to surface waters. However, either broad approximations or a very thorough stormwater infrastructure survey must be completed to determine EIA.

Methods

Thurston County used the most current landcover data sets available from local, state, federal, and tribal sources. Thurston County acquired and processed 2005/2009/2010 SPOT 10 meter imagery for the current efforts. These data are high quality but not perfect; the overall accuracy for this project's area landcover classification is 84%.

See also Hulse et al. 2002, A suggested further reference on mapping error and generalization, particularity in relation to land use policy and decision making.

No field verification of landcover data was performed. Actual condition of the landscape would need to be evaluated when a specific land-use project is proposed.

Data Needs

Available satellite landcover classification data.

Product

Land cover classification yielded 15 classes for land cover analysis and indicator development purposes. The 15 classes were type verified by aerial photography, acquired in 2005, the same month as the satellite imagery and limited field visits. A classification accuracy assessment yielded combined class results as 84% accurate.

Step 2C. Select or Create a Future Landcover Data layer

The reference to future land-use values has been discontinued in the methods. It is a goal to determine direct measurement of impervious values in Thurston County using the 2005, 2009, 2010, 10-m spot satellite data. This time frame includes rapid conversion of the vegetated landscape to the built-environment. It was determined during the Henderson work that any future land-use scenarios, based on current Thurston County zoning, would not provide any useful information. This is based on the fact that the majority of unincorporated Thurston County is zoned 1:5, and there are many non-conforming lots that were platted decades ago. However, Thurston Regional Planning Council has population forecast data that could be utilized to predict future build-out scenarios in the future.