



February 19, 2008

Randell Greer, PE
Department of Natural Resources and Environmental Control
Division of Soil and Water Conservation
89 Kings Highway
Dover, DE 19901

**SUBJECT: Murderkill Watershed Management Plan
Work Plan and Fee Proposal – REVISED**

Dear Mr. Greer:

URS is pleased to submit four copies of our proposed work plan and associated fee proposal for the above-referenced project. The information provided with this letter is listed below:

- Work Plan
- Project Schedule
- Fee proposal showing detailed labor hour breakdown for each task
- Overall summary of fees by task

The above documents, which were previously submitted to you on January 31, 2008, were revised to reflect discussions in a February 19, 2008 telephone conference with you, Frank Piorko of your office, and Mary Roman of our office.

We appreciate the opportunity to present this information to you. If you have any questions or require additional information, please feel free to contact me at 301.670.3315 or our project manager Mary Roman at 410.487.8954.

Sincerely,
URS CORPORATION

John D. Bowers, PE
Vice President

Murderkill Watershed Management Plan Work Plan

Watershed Background

The Murderkill watershed comprises about 104 square miles south of Dover, Delaware and generally drains in an easterly direction. Nearly three-quarters of the land is in agricultural use and only 6 percent is residential. Natural features such as wetlands and wooded areas make up another 17 percent. Commercial land is almost nonexistent at less than 1 percent. However, development pressures in the watershed are significant. Much of the area between Route 13 and Route 113 is designated as a growth area in the Kent County Comprehensive Plan.

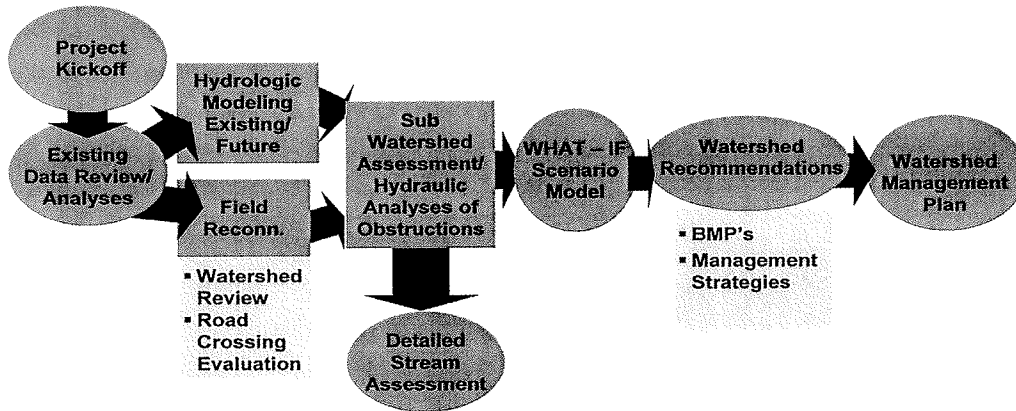
The river is tidal to about the Route 113 Bridge in Frederica. From there, the Spring Creek and its tributaries, including Pratt Branch, Hudson Branch, McGinnis Pond, and Double Run Branch, flow from the north. Farther inland, Browns Branch flows from the south including McColley Pond, while the main stem of the Murderkill continues in generally a west-east direction. Killens Pond and Coursey Pond are both located along the main stem midway between Routes 13 and 113.

The Murderkill River water quality report indicates that high nutrient loads, high bacteria counts, and low dissolved oxygen are concerns within the watershed. Pathogens, nutrients, physical habitat condition, and water supply are the main concerns within the watershed. The report states that fish, aquatic life, and wildlife were partially supported in 8% and were not supported in 91% of the 126 river miles assessed in the watershed. Dissolved oxygen, biology, and habitat are causes of impairment. However, aquatic life was fully supported in the 231 pond acres assessed in the watershed.

Project Overview

The project flow chart is depicted on the following page. The first part of the project involves data collection and review, field reconnaissance, and hydrologic modeling. The second part involves a subwatershed assessment, detailed stream assessment, development of a what-if scenario model, and developing watershed recommendations to restore and maintain watershed quality.

Murderkill Watershed Management Plan
Project Flowchart



Project Tasks

1. Data Collection, Review, and Analyses

The Murderkill watershed has been the focus of several studies. To the extent practicable, we will maximize the use of existing data in the development of the watershed management plan. An effective program to collect and review existing data will lay the groundwork for a successful watershed management plan.

URS Corporation (URS) will identify, compile, and review environmental information pertaining to the watershed. These data include previously completed studies and other available data collected by public and private organizations. URS will review available data including drainage studies, general development plans and updates, and other studies pertinent to the watershed. While extensive analyses and reports have been completed on the Murderkill watershed, some of it may be outdated or be for areas outside of our study area. Experienced engineers and environmental scientists will efficiently cull the information for relevance to the development of the Murderkill Watershed Management Plan.

a. Existing Data

It is assumed that the Delaware Department of Natural Resources and Environmental Control (DNREC) will provide available existing data to URS in geographic information system (GIS) format, where available. Available GIS data will be compiled and integrated into the project GIS include the following:

Murderkill Watershed Management Work Plan

- Comprehensive land use plans and current zoning maps to develop a build-out scenario for the future land use data layer for modeling purposes
- Existing and proposed stormwater control facilities and flood control projects
- Existing utility information (e.g., stormdrain, water, sewer)
- Master plan for future water and sewer service
- Soils
- Geology
- Flow obstructions
- Topographic mapping
- Aerial photographs
- Streamflow data
- Rainfall data
- Floodplain information
- Delaware Green Infrastructure maps and reports
- Rapid assessment of Green Infrastructure, Kent County, Delaware
- Water quality reports
- National Wetland Inventory maps
- Statewide Wetland Mapping Project (SWMP) maps
- Tidal wetland maps
- US Fish and Wildlife Service wetland trends report
- Delaware Ecological Network maps
- Public land identification
- Designated recharge areas
- Existing agricultural nutrient management programs at the Conservation District
- Additional Delaware GIS data

b. Review of Existing Plans and Studies

URS will review related technical documents and programs as provided by DNREC and the stakeholders after the first stakeholder meeting. Existing documents that may be reviewed include:

- Water supply and wellhead protection plans
- Engineering and planning studies for major developments within the watershed
- Flood mitigation plans
- Municipal wastewater management plans (various)
- Flood Insurance Study for Kent County, Delaware, from the Federal Emergency Management Agency
- Municipal ordinances

In addition, the following references will be reviewed prior to developing restoration opportunities in the Murderkill watershed:

- *Center for Watershed Protection, Technical Memorandum: "Prioritization of Murderkill Watersheds"*
- *Designing Large-Scale Wetland Restoration for Delaware Bay*
- *Partnerships in Wetland Rehabilitation at the Milford Neck Focus Area*
- *Managing Delaware's Coastal Wetlands for Biodiversity*
- *Open Marsh Water Management – A Source Reduction Technique for Mosquito Control*
- *Mosquito Control: Balancing Public Health and the Environment in Delaware*
- *Northern Delaware Wetland Rehabilitation Program*
- *Delaware's Wetlands – Status and Trends*
- *Stream Order Analysis in Marsh Restoration on Delaware Bay*
- *Salt Marsh Tidal Channel Morphometry: Applications for Wetland Creation and Restoration*

c. GIS Project Development

The development of the Murderkill Watershed Management Plan will rely heavily on available GIS data. A GIS specialist with expertise in locating and acquiring existing GIS data will be involved in this effort. The GIS specialist will also organize data flow procedures and begin structuring a data scheme for the project.

URS will use ESRI (Environmental Systems Research Institute) products, such as ArcGIS 9.1, ArcInfo 9.1, ArcIMS 9.1, ArcView 3.x and ArcSDE in a Windows environment. We can provide shape files for any data that we generate in an ESRI format that will include a projection file for the defined map coordinate system.

As appropriate, existing available data will be incorporated into the GIS for the project. URS will also use the GIS to conduct hydrologic modeling (Task 3) and to support the field reconnaissance (Task 2).

d. Input from Stakeholders Group

As described in Task 11, stakeholder meetings will be held throughout the project. One of the goals of the first stakeholder meeting is to request available data for review. We will request information on known problem areas in the watershed. These problem areas may consist of flooding areas, undersized culverts, stream erosion, and water quality problems.

e. Data Assessment

URS will analyze the existing data and prepare a comprehensive data review/assessment. The data assessment will include a comprehensive list of documents that were reviewed for applicability to this study. Our assessment will focus on data that are suitable for use in the Murderkill Watershed Management Plan. The data assessment will also identify areas for the field reconnaissance (Task 2).

2. Field Reconnaissance

a. Watershed Review

URS will conduct a field reconnaissance of the Murderkill watershed. A comprehensive understanding of the available information and thorough understanding of the GIS data for the watershed will enable us to target areas for field review. Portions of the field reconnaissance described below will be conducted throughout the project, as appropriate. In particular, we will target the following areas during the field reconnaissance:

- *Developed areas* – to review general watershed and stream conditions in the developed portions of watershed.
- *Undeveloped areas* – to review stream conditions in representative undeveloped areas and to identify watershed resources to be considered for protection and/or enhancement.

- *Known problem areas* – to identify best management measures to address known problem areas..

For the purpose of this contract, it assumed that a two-person team will conduct 6 days of field reconnaissance. Field sheets will be developed to ensure that accurate, complete, and consistent information is collected for each site.

Data acquired during the field assessment will be recorded on the field sheets and entered into the GIS to assist in the overall assessment per subwatershed for the entire study area. Digital photographs will be taken.

b. Field Evaluation of Road Crossings/Obstructions

One of the key focus areas for the Murderkill watershed study is to identify capacity deficiencies for stream obstructions, including bridges and culverts within the watershed. Prior to reviewing obstruction in the field, URS will obtain available obstruction information from the DelDOT bridge maintenance group. URS will conduct field visits to road and railroad crossings that have an opening of 36-inches or greater to collect the following data:

- Crossing opening data (e.g., type, culvert/bridge size, culvert material, headwall material/configuration,, culvert skew)
- Distance from the top of the opening to the minimum overtopping elevation.
- Configuration of downstream channel (to compute outlet control discharges)
- Distance from the downstream invert to the low flow elevation below the culvert will be measured to determine whether a blockage to fish passage exists. Other downstream conditions such as bank erosion, over widening, and bed degradation will be noted
- Digital Photographs
- GPS location of upstream and downstream culvert opening
- Evaluate potential for conveyance improvements
- Other pertinent data necessary for hydraulic computations (see Task 4)

For the purposes of this planning level watershed study, the information will be obtained using a tape measure and field observation rather than a detailed field survey. It is assumed that the majority of the crossings will be culverts. For bridges, it is assumed that the opening data will be available from DelDOT. Note that assessment of existing dams is not included.

Based on stream information from the 1:24000 National Hydrology Dataset (NHD) which matches the USGS topographic maps and road information from Tele-Atlas enhanced Tiger 2000 data, there are 182 road and railroad crossings. For this proposal,

we estimate that 150 of these crossings will be 36-inches or greater and therefore, up to 150 field assessments will be conducted.

3. Hydrologic Model Development

To aid in the development of watershed characterization and effectiveness of proposed management measures, hydrologic modeling will be conducted for the Murderkill watershed. URS will develop a watershed level HEC-HMS model for two land use scenarios:

- Existing land use – based on aerial photographs
- Future land use – based on zoning information from the Kent County Growth Plan

Existing stormwater management measures that affect the watershed's hydrologic characteristics (e.g., greater than 50-acre drainage area) will be included in the model based on available existing information about the structures. It is assumed that data necessary for the hydrologic model is available in digital format (e.g., soils, land use, zoning). The future conditions model will not include proposed management facilities; rather stormwater management scenarios will be considered under the Task 7, the "what-if" scenario modeling.

a. Delineate Subwatersheds

The watershed and subwatersheds will be established based on the data and results of the field reconnaissance task. The major subwatersheds will be depicted as outlined in the 2005 Technical Memorandum prepared by the Center for Watershed Protection. This breakdown of the watershed by major tributary drainage courses and points of interest will be the basis for the hydrologic analyses. In addition, the subwatersheds will be delineated based on the following:

- The location of existing problems, as identified by stakeholders, during the field reconnaissance, or from the existing data review,
- The locations of major obstructions (primarily bridges), highway culverts, or stormwater control facilities,
- Confluence points of tributaries, as deemed appropriate based on engineering judgment and good modeling practice, and
- Other points of interest, such as stream gaging or water quality monitoring stations, locations of water quality concerns, or outfall sections downstream of existing developments or where development is anticipated to occur.

b. Model Calibration

The model will be calibrated using available data. Calibration efforts will include the adjustment of model parameters to accurately simulate natural runoff conditions of the watershed. URS will consider calibration techniques including use of available gaging

information, comparison with available rainfall and runoff information from similar watersheds, and comparison with Flood Insurance Study information.

c. Design Storm Selection

URS will perform hydrologic modeling for the 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year 24-hour storms. In addition, we will also analyze the “water quality event” as defined in the Delaware Sediment and Stormwater Regulations.

d. Hydrologic Model Results

URS will present the results of the hydrologic modeling in tabular form as appropriate. Percent increase in discharges from existing to future land use will be computed. We will also provide graphical representation of the increase in discharges using the project GIS. Percent increase in discharge will be color-coded to enable quick evaluation of watershed areas that have the greatest potential for impact due to development.

4. Hydraulic Analyses of Road Crossings/Obstructions

URS will evaluate hydraulic capacity of existing bridges and culverts in the Murderkill watershed. These analyses will be conducted for stream crossings for all “blue line” streams as described in Task 2. This analysis will be conducted using data collected under Task 2b. URS will use a nonproprietary software program, such as HY-8, to evaluate the capacity of the existing structures. For outlet control computations, we will assume a pipe slope of 0.5 percent unless design plan data is available. A table will be presented which lists culvert/bridge size, flow capacity, approximate return period under existing and future conditions, and maintenance issues that were noted in the field.

As part of this task, URS will also evaluate the potential for providing conveyance improvements, and we will recommend proposed modifications and resulting capacity and associated return period.

Each stream crossing will be categorized as “green”, “yellow”, or “red” based on the capacity of the opening versus the existing and future flows for a set design storm as specified by DNREC. The coloring scheme will illustrate the location of crossings with the most significant capacity issues under existing conditions and where they are anticipated to be under future land use conditions.

5. Assessment of Subwatersheds

Based on available data, discussions with DNREC, Kent County, and the Kent Conservation District, the field assessment, and hydrologic analyses tasks, the URS team will develop a qualitative approach to evaluate the subwatersheds. The purpose of this task is to identify areas to target for the stream assessment (Task 6) and determine baseline conditions for the what-if scenario modeling (Task 7). This prioritization of the stream system will also be used to target proposed management alternatives (Task 8).

Subwatersheds will be qualitatively ranked as good, fair, poor, or very poor. The subwatersheds will be evaluated with respect to numerous factors such as:

- Hydrologic and hydraulic analyses results (Task 3 and 4)
- Field reconnaissance efforts (Task 2)
- Watershed conditions
- Average stream buffer width
- Percent existing impervious of subwatershed area
- Percent existing forest cover
- Future development potential

URS will depict subwatershed quality graphically using the GIS.

6. Stream Assessment

A rapid yet comprehensive field reconnaissance will be conducted along select reaches of the Murderkill River tributaries to assess the general condition of streams in representative subwatersheds. The stream stability assessment will be based on the Rosgen Classification System and stability analysis tools. Six stream reaches of up to 500 feet in length will be assessed. The reaches to be visited will be selected based on Task 5. The locations will be provided to DNREC for concurrence prior to conducting the assessment.

Several sub-tasks will be performed in preparation for this assessment including:

- Estimation of expected values for bankfull channel dimensions versus drainage area from regional curve data originally published by Leopold, 1994, from US Fish and Wildlife and other sources.
- Preparation of field data sheets to facilitate data collection during the field reconnaissance task.
- Determination of reach locations from GIS or other available mapping.

To properly classify the streams, riffle cross sections from top-of-bank to top-of-bank, and a surface water slope measurement, will be selectively conducted at representative locations within the watershed. A surveyor's level and rod will be used for taking the measurements. Bank and bed features will be noted for each cross section, including top-of-bank, estimated bankfull elevation, left and right edges of water, and thalweg. Bankfull channel dimensions including width, depth, cross-sectional area, and entrenchment will be measured. Photographs of the cross section from the upstream and downstream perspectives will be taken. Photographs will also be taken elsewhere along the reach in areas of degradation and aggradation.

Existing available topographic maps will be used to calculate sinuosity. Manning's "n" values will be periodically estimated from pebble counts taken in the field. Using these

parameters, a Rosgen Stream Classification will be derived for each reach, as well as bankfull discharge and bankfull channel geometry. An appropriate reference reach spreadsheet model will be used to facilitate the analysis. Other stream channel observations will include vertical and horizontal stability, habitat features and abundance, fish blockages, tree shading, water clarity, coarse woody debris, and trash. Infrastructure conflicts and failures, which are frequently observed in urban streams, will also be recorded on the maps and field sheets.

The overall health of the stream is closely related to the condition of the riparian zone. Riparian zone parameters such as adjacent land use, dominant vegetation, width of average forested buffer, vegetative density, and invasive plant cover will be qualitatively examined and noted.

Data collected for this task will be presented in the Murderkill Watershed Management Plan report (see Section 10 below).

7. What-If Scenario Models

To assess DNREC and other stakeholders in making watershed management decisions, URS will develop “what-if” scenario models. The GIS-based models will be developed using results of the hydrologic and hydraulic analyses. The what-if scenarios will model the impact of various stormwater management options on current and future subwatershed conditions. The scenarios will likely include options to provide volume and discharge management requirements per DNREC stormwater management criteria. These criteria will likely include the following:

- Water quality
- Groundwater recharge
- Streambank erosion
- Overbank flooding
- Extreme events

In addition, what-if scenarios may also include:

- Change in zoning for future development
- Retrofit of existing stormwater management facilities
- Changes to design standards for future development, (e.g. required 48-hour detention)
- Regional versus localized stormwater management facilities
- Culvert improvements

- Implementation of additional stormwater management strategies

URS will run the scenarios for a specific subwatershed for each proposed option and any impacted downstream subwatersheds. What-if scenarios will be modeled for up to 16 scenarios for affected subwatersheds. The what-if scenarios will be selected based on the subwatersheds with current or anticipated future problems (as identified in Tasks 4 and 5) and those options anticipated to have the highest potential for success.

8. Proposed Improvement Measure Identification and Evaluation

URS will recommend site-specific structural management alternatives to improve, restore and enhance the natural resources of the Murderkill watershed. Measures to be identified and evaluated include:

- Water quality, infiltration, and quantitative stormwater management measures/BMPs
- Retrofit of existing stormwater management opportunities
- Bridge/culvert improvements
- Stream restoration measures

Potential improvement measures will be recommended for implementation. We will provide a cursory assessment of each measure to include an evaluation of the following factors: relative effectiveness, environmental impacts, cost considerations, constructability, and relative level of improvement provided. URS will provide a summary table of identified potential measures. Each measure will be shown graphically in the GIS. This task does not include conceptual design of the alternatives, hydrologic or hydraulic modeling, preparation of graphics, and cost estimate development.

9. Management Strategies/Action Items

In addition to restoration projects, URS will identify management strategies and action items for consideration. These broader range initiatives will complement the proposed restoration projects. The recommendations will be based, in part, on the “what-if” scenario modeling. Examples of management strategies/action items are provided below:

- Identify and recommend specific standards and criteria for stormwater management on a subwatershed level.
- Provide recommendation on implementation of stormwater management ordinances to protect and enhance natural resources on a subwatershed level. DNREC’s revised stormwater management ordinance will likely be available at the time this task is conducted.
- Review applicable municipal stormwater ordinances and identify ordinance provision recommendations on subwatershed basis.

- Recommend specific protection areas within the Kent County designated Growth Zone. As stated, the Murderkill watershed is relatively undeveloped. The County has already established the Coastal Zone Protection Overlay District and established a Growth Zone that encompasses a substantial portion of the watershed.
- Identify management strategies to support recommendations in the existing dam inventory study.
- Additional watershed wide management strategies will also be considered for implementation, including
 - Identify opportunities with related ongoing programs (e.g., DelDOT National Pollutant Discharge Elimination System (NPDES) stormwater program, Delaware Bay initiatives, and agricultural nutrient management programs).
 - Identify specific activities for long-term stakeholder involvement and public outreach programs focusing on holistic watershed protection and water quality improvement requirements.
 - Develop Low Impact Development programs for private property owners.
 - Work with regulators to consider alternative mitigation projects such as the natural restoration of tax ditches or tidal marsh improvements.

10. Report Production/Deliverables

The end product of the Murderkill Watershed Management Plan is a report. This document will summarize all project elements and include recommendations and strategies for future action items. URS recognizes that clarity and presentation of this document are important to facilitate its future use. As we do with all of our reports and technical documents, URS technical writers, editors, and graphics personnel will assist in providing a high quality product.

The document will be organized in a manner that will allow the reader to easily access any of the information produced over the course of the study. The report will be organized as a set of volumes containing the main report followed by appendices containing backup data, figures, calculations, etc. Oversized maps will be included in the appendices to the main report. Liberal use of figures, tables, graphs, and maps will add to the overall ease of use of the document by DNREC and other users.

URS will prepare a draft version of the Murderkill Watershed Management Plan, with a final version being submitted within 30 days after receipt of review comments. Six bound copies and digital copies will be provided. As part of the final submittal, digital data developed for this study will be provided including hydrologic and hydraulic modeling

files, GIS databases, and electronic data and maps. Digital deliverables will be provided in a format consistent with DNREC's Information Technology's data standards.

11. Stakeholder Meetings

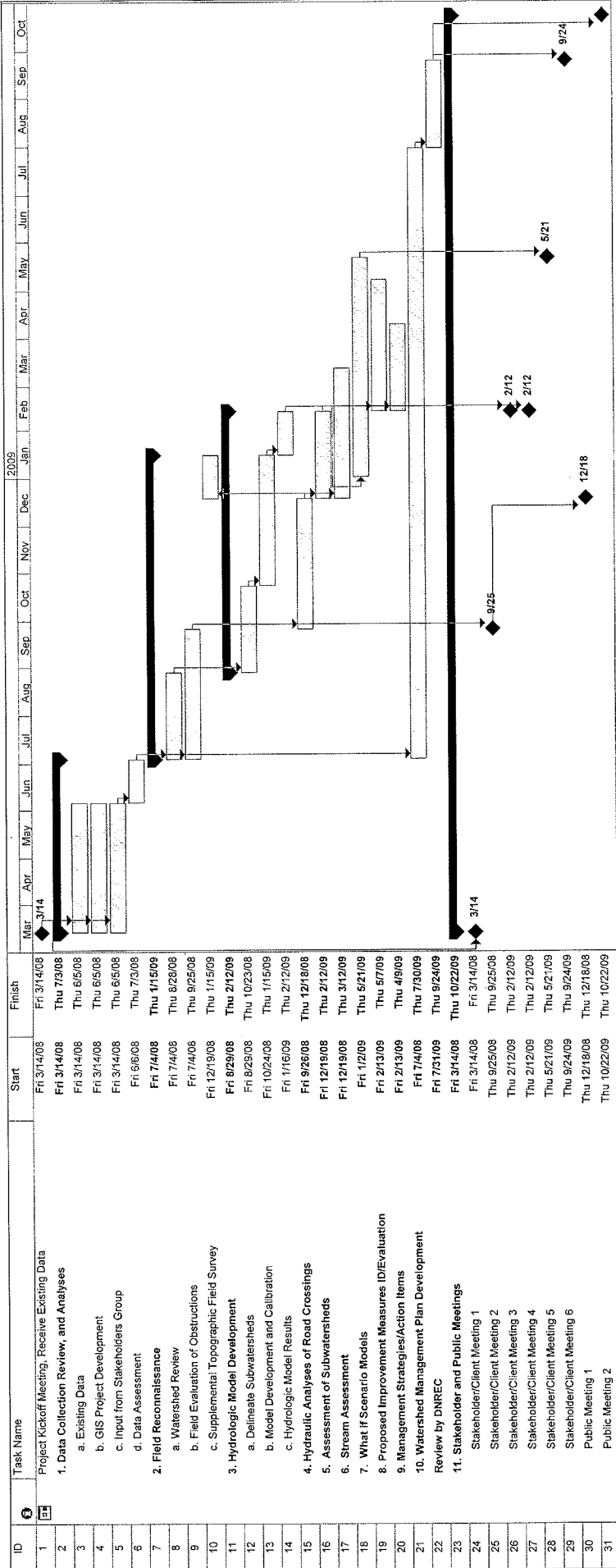
It is our understanding that the watershed workgroup/stakeholders group initially consists of members from the DNREC, DelDOT, the Conservation District, and municipalities. URS' approach is to work in partnership with the stakeholders group. We feel that interaction with our clients, work groups, and stakeholders is instrumental to the success of watershed management plan development. Up to four stakeholder/client meetings will be conducted to coordinate project efforts throughout the duration of the project as described below:

- Kick-off Meeting – to introduce the stakeholders to the planning process and to establish the degree of involvement planned throughout the study.
- Progress Meetings 1 and 2 – to be scheduled as the project progresses, based on need.
- Draft Watershed Plan Review Meeting – To present the draft plan.

Project Schedule

The project schedule for the development of the Murderkill Watershed Management Plan is provided separately. This schedule depicts submittal of the Implementation Plan in an 18-month timeframe from the Notice to Proceed.

Murderkill Watershed Management Plan - Project Schedule



Project: Murderkill Schedule
Date: Thu 1/31/08

Task Milestone Progress Summary External Tasks External Milestone Deadline