Devola/Putnam Project
Unsafe Water Investigation
Sample Plan

7/20/2010

1. Project Scope and Purpose

A. Problem/Issue to be Addressed

Putnam Community Water Association serves water to Devola in Washington County, Ohio. Putnam relies on groundwater derived from an alluvial aquifer adjacent to the Muskingum River as their primary source of drinking water. Putnam's wellfield includes four closely spaced supply wells that withdraw about 250,000 gallons per day. In 2009 Putnam Community Water Association entry point samples exceeded the nitrate Maximum Contaminant Level (MCL) of 10 mg/L. Historically the nitrate concentration has been increasing since 2008 when nitrate concentrations were around 8 mg/L nitrate as exhibited in Figure 1. The nitrate time series, however, exhibits a significant amount of variability. In late 2009 (November 18 to January 5, 2010) nitrate samples consistently exceeded the nitrate MCL. Nitrate may originate from a variety of sources including fertilizers, septic discharge, animal wastes, atmospheric sources, and decaying plant debris. Even though the wells at the Putnam wellfield and other wellfields along the Muskingum River in Washington County are screened at similar depths and in similar lithologies, nitrate concentrations vary significantly between wells from below detection (less than 0.1 mg/L) to more than 10 mg/L (exceedance of the MCL). The purpose of this project is to identify the sources of nitrate to the Putnam wells in order to help develop plans to reduce the increase of nitrate concentration in the Putnam PWS wells to avoid acute exceedances of the nitrate MCL.

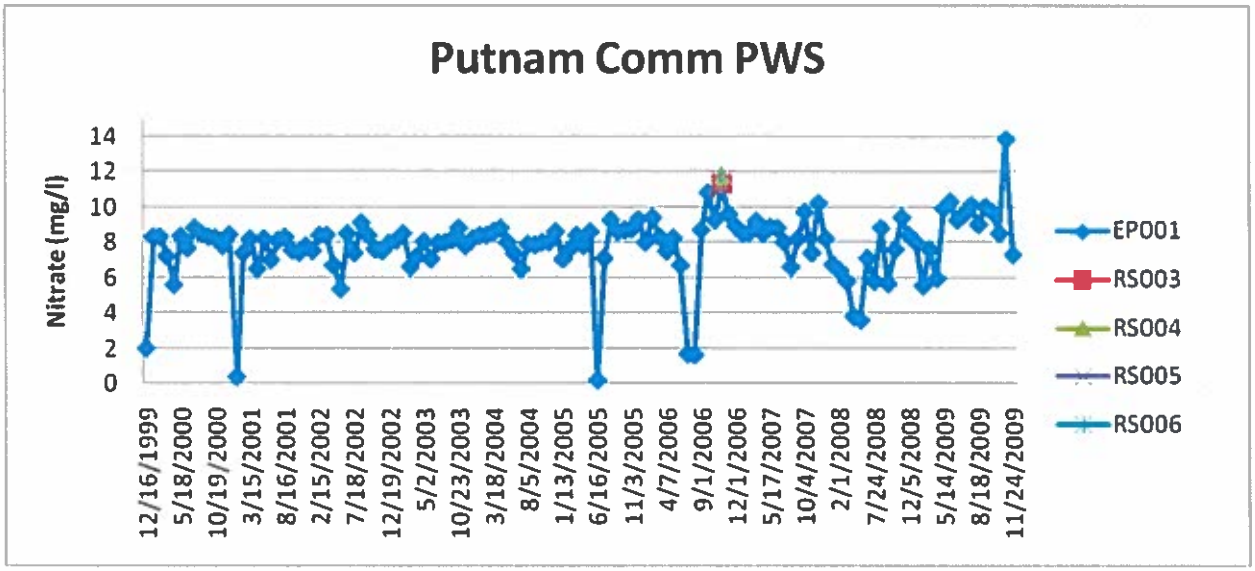

Figure 1. Nitrate time series for Putnam Community Water Association

A nitrate issue that may be related occurs at the Masonic Park, which is located approximately a mile northwest of the Putnam well field in an area of agricultural land use. Figure 2 illustrates the increasing trend of nitrate since 2000 at Masonic Park. The nitrate samples collected after the 6/18/09 sample (12.5mg/L) which exceeded the nitrate MCL have been below 10 mg/L. The Masonic Park is located close to a nursery which may be contributing to the local nitrate concentrations in the ground water or the wide spread agricultural land use is contributing significant nitrate to the ground water. Either way, the nitrate sources at the Masonic Park need to be understood to understand the nitrate inputs at the Putnam Community Water Association. The nitrate samples collected by Kristyn Robinson for her 319 Grant in the area west of Devola suggest that nitrate concentrations are variable in the agricultural area and likely to be associated with contamination by local nitrate sources. Nitrate concentrations at some wells are consistently non-detect or in the 1 mg/L range while other wells exhibit elevated nitrate in the 6-9 mg/L range.

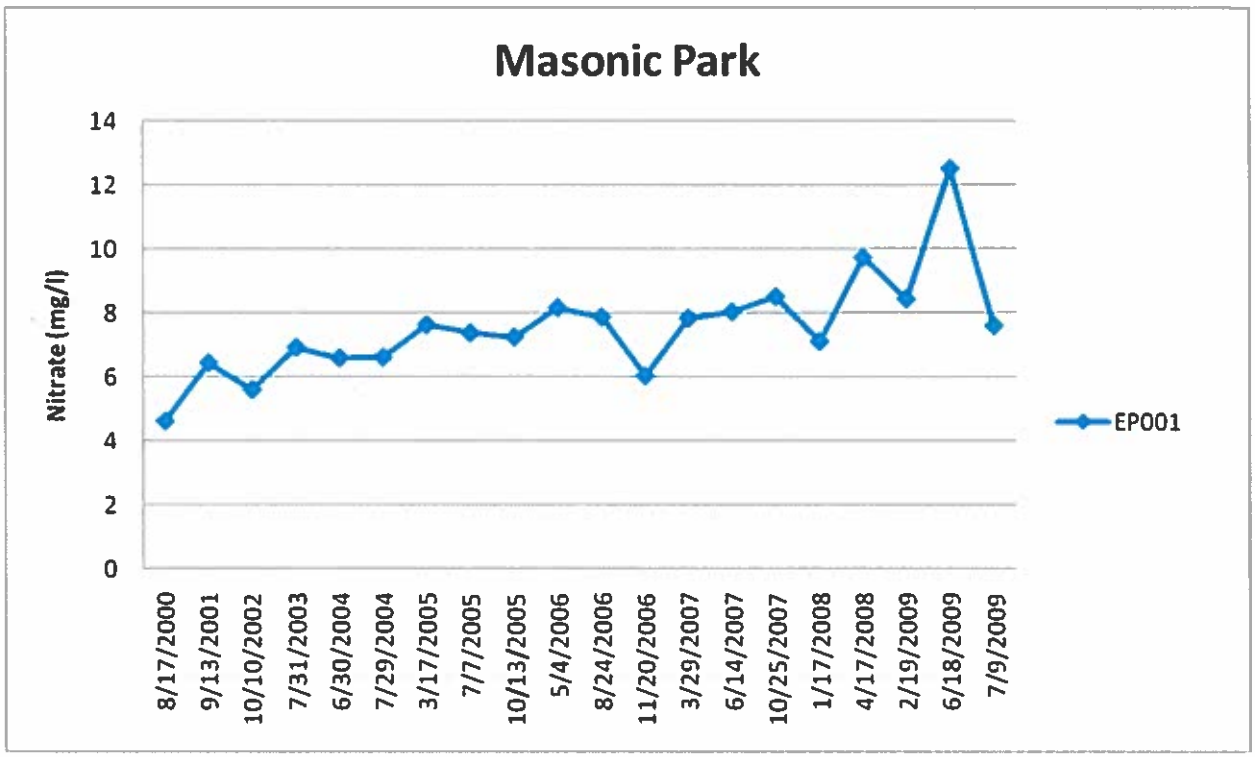

Figure 2. Nitrate time series for Masonic Park

B. Project Team

Kristyn Robinson; Friends of the Lower Muskingum River
Michael Eggert, Mike Slattery, Ben Reed, and Chris Kenah; DDAGW, Ohio EPA
Ed Gortner, Karl Rienbold, and Jeff Wander; DEER-SIFU, Ohio EPA
John Kuch and Jay Huck, Putnam Community Water Association
Chris Impellitteri and Kathy Schenck; Water Quality Management Branch, U.S. EPA
Ken Robinson; Washington County General Health District

C. Background Information

Elevated nitrate in the region of the Lower Muskingum River has been a problem for more than a decade. Several other PWS in the Lower Muskingum River Valley also demonstrate elevated nitrate and increasing trends, but the Putnam Community Water Association exhibits one of the steeper trends, as exhibited in Figure 1, with significant increasing nitrate trends in 2004 -2006 and 2008 - present. The late 2009 exceedance of the nitrate MCL at Putnam identifies them as the community PWS with an acute need to identify the sources of nitrate impacting their wellfield. The data presented in Figure 1 exhibits scattered low nitrate samples and variability in the entry point data suggesting there are some complex recharge patterns influencing the production water. The Washington County Health Commissioner, Dr. Meckstroth, requested an unsafe water supply investigation in a May 12 letter and Director Korleski indicated that an investigation would be initiated in a June 7 letter to Dr. Meckstroth.

D. Identify the Purpose of the Proposed Sampling

The purpose of the proposed Geoprobe borings is to identify the local water table surface and to collect ground water samples at multiple locations and at various levels (at and below the water table) to evaluate nitrate concentrations flowing to the Putnam production wells from areas with different land use and nitrates sources.

Statements of Sampling Objectives

D1. To collect data to identify the local water table to identify ground water flow directions to the Putnam Wellfield and to the Muskingum River;

D2. To collect water samples to determine the nitrate concentration (and other nutrients) at the water table and at depths below the water table associated with various land uses in the area; and

D3. To analyze the GW samples for additional parameters that will help trace or identify the source of nitrate contamination (Cl, Br, TOC (?), isotopes, redox parameters, and personal care products).

2. Project Study Area

The study area is located in Muskingum Township in Washington County approximately five miles up the Muskingum River from its intersection with the Ohio River at Marietta. The area of interest is the portion of the Muskingum River buried valley aquifer that is north and east of the Muskingum River at Devola and upstream from Devola. The study area is the area of Devola that is uphill from the Putnam PWS Wellfield and includes the agricultural areas in the Muskingum buried valley west of Devola. The general area is included in Figures 3 and 4, which illustrate the proposed locations for Geoprobe borings over a topographic base and air photos respectively.

3. Project Design

A. Sample Location Selection

The purpose of the Geoprobe borings is to sample the ground water at various locations and depths below the water table. The locations of the proposed Geoprobe borings are exhibited in Figures 3 and 4.

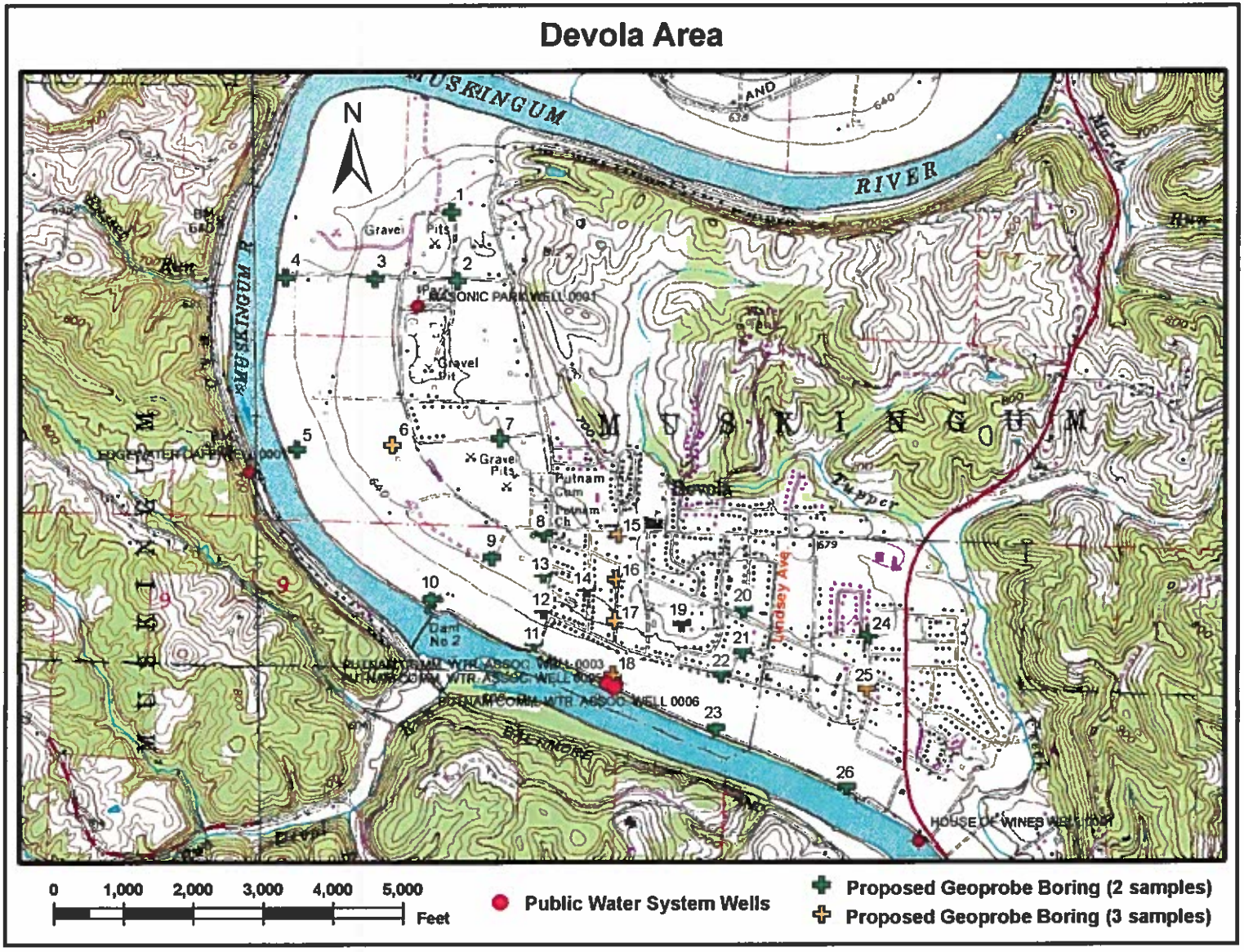

Figure 3. Proposed Geoprobe boring locations plotted on topographic base map.

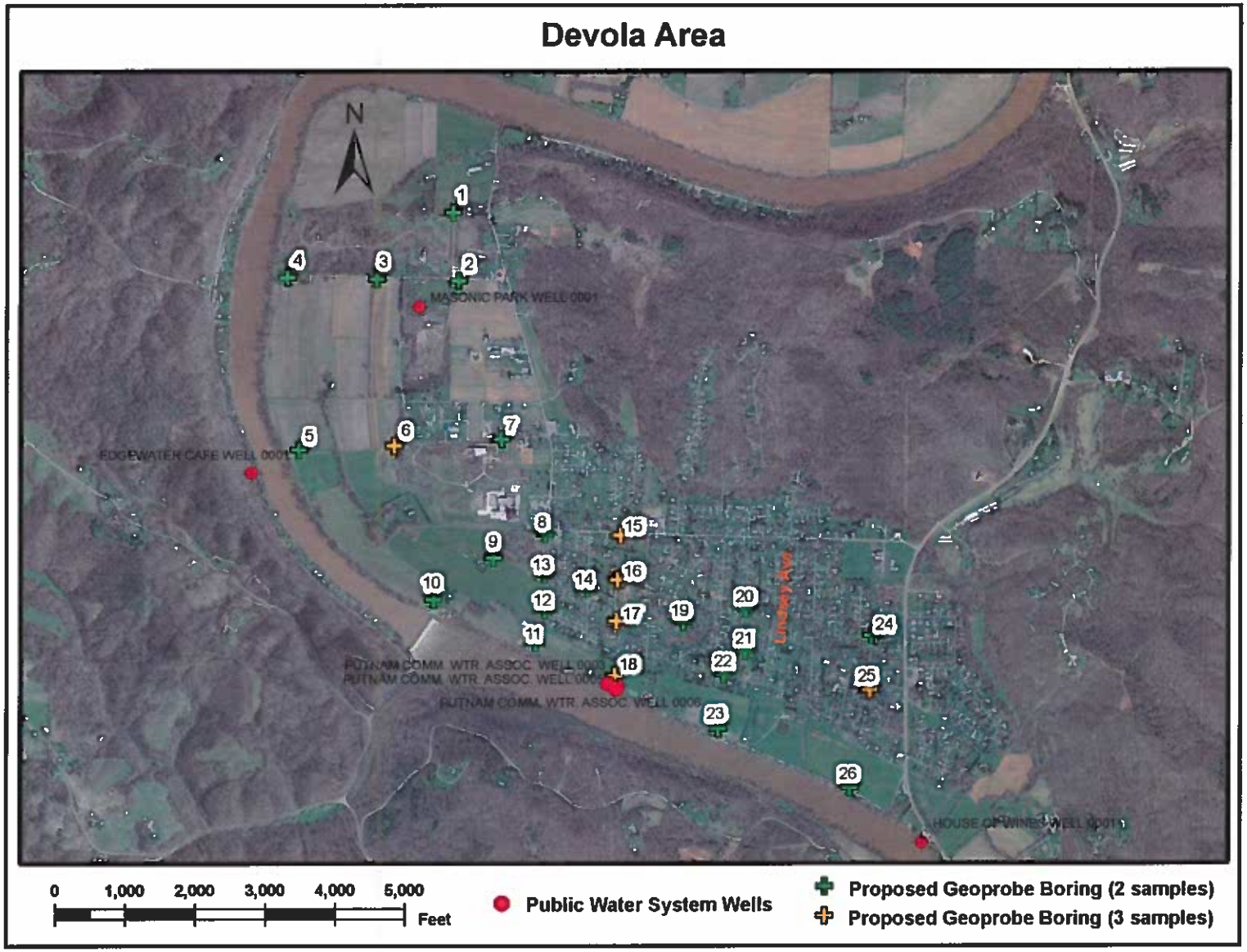

Figure 4. Proposed Geoprobe borings locations plotted on air photos.

The locations of the borings are selected to test the water quality of areas with different land use and septic disposal options and have been revised to accommodate input from the 6/22/2010 meeting discussions. The borings west of Devola are expected to be dominated by agricultural land use. The borings in Devola west of Lindsey Avenue will document the Devola septic contribution from the unsewered portion of Devola. The borings east of Lindsey Avenue will document the nitrate contribution in sewered portions of Devola, in order to document differences with the nitrate contribution in unsewered areas. The borings along the river bank will evaluate the nitrate concentrations flowing to the Muskingum River from agriculture areas, unsewered and sewered areas, or document river recharge to the Muskingum River buried valley aquifer.

Most of these borings (green +) will sample ground water at 2 depths: at the water table (4 foot screen); and approximately 28 to 32 feet below the water table. Six borings (orange +) will have three samples collected: at the water table (0-4 feet below the water table) mid way between the water table and total depth (TD), and at the bottom ot the boring (TD - 4 feet). These samples at various depths at and below the water table will document nitrate concentrations and the redox state through the aquifer. The ability to penetrate the overburden and aquifer will dictate the final sample depth within the borings and the number of samples collected in each boring.

B. Parameter Selection and Sample Collection Protocol

The selection of parameters for the boring water samples is designed to document variations in nitrate concentrations, to evaluate the oxidation state of the aquifer and to collect several parameters that are good tracers for determining the source of the elevated nitrate. Ground water samples will be analyzed for:

- Nutrients (nitrate, ammonia, and TKN) for a direct measure of the nitrate concentrations along distinct flow paths to the production wells;
- Chloride and bromide as a tracer for softening salts in septic discharge;
- Iron, manganese, and sulfate for documenting oxidation state in the aquifer;
- Alkalinity as measure of bicarbonate (inorganic carbon), and TOC as a measure of organic carbon input, suspected to be elevated in the unsewered portions of Devola;
- Field parameters (ORP, pH, temperature, TDS, conductivity, dissolved oxygen and turbidity);
- Stable isotopes of nitrogen and oxygen in nitrate, and the stable isotopes of water; and
- Personal care products or pharmaceuticals.

The Geoprobe boring ground water samples will be collected by driving the probe to depth and then collecting ground water samples as the probe is pulled out. To collect a water quality sample the casing will be retracted exposing a 4 foot screen. Water will be pumped from this sample point (using a check valve pump) to remove some fines and to purge the screen and tubing to assure the sample collected is representative of the aquifer at the screen depth interval. Geoprobe boring ground water samples are turbid so all ground water samples for metals (HNO_3 preserved) will be filtered in order to collect water typical of water produced from a properly developed well. For a subset of the samples, non-filtered and filtered cubies will be collected for non-preserved and H_2SO_4 preserved cubies in order to evaluate the influence of turbidity.

Isotope samples and **inorganic samples** will be collected and analyzed at every sample location. **Field parameters** will be collected and recorded for each sample. The distribution of isotope and inorganic samples will be collected in order to characterize the

ground water associated with the sewered, unsewered, and agricultural areas. In addition, isotopes samples of probable sources or mixing end members will be collected (sewage, surface water etc.) as well as the PWS itself in order to identify the nitrate sources at the Putnam Community Water Association.

The number of pharmaceutical and personal care products (PPCPs) samples will be limited. These samples will be analyzed by the U. S. EPA lab in Cincinnati and the analytical process is currently being set up. Kathy Schenck and Chris Impellitteri are working hard to accommodate our needs to test for a subset of PPCPs. The analytes currently included in this UPLC/MS/MS method being developed/setup are: ethynylestradiol, estradiol, estriol, estrone, testosterone, dihydrotestosterone, atrazine, bisphenol A and triclosan. Most of these are hormones related to birth control products with an herbicide, a plastic and epoxy ingredient, and a ubiquitous antibacterial agent used in personal care products included. This is the scan that is available to us and a positive detection for these compounds would help document the presence of a waste water component in the Putnam source water, as we suspect. Two samples from Putnam PWS production wells and 3 samples from a single boring will be collected. The PWS wells themselves provide the best integrated sample. The longer travel times in ground water systems may allow the decomposition of these compounds so one boring within Devola (boring 16) closer to the septic sources in the unsewered area will also be sampled.

Table 1 lists the borings by number, indicates the number of samples that will be collected from each boring, and specifies what samples will be collected. VOC samples will not be collected because the Putnam compliance samples have not detected VOC compounds.

C. Data Analysis

The elevations of the water table as determined in the Geoprobe borings is critical for understanding the local ground water flow directions. Thus the static water level needs to be measured at all sample points and we need DERR - SIFU to collect GPS elevations for each boring at the end of the boring activity. The flow directions determined by the contoured water table measurements will be critical to the data analysis and to associating local nitrate sources to elevated nitrate in ground water. The elevations of the water table will also be provided to John Kuch (board member of the Putnam Community Water Association) for inclusion in the Modflow model he developed to improve the representation of local ground water flow directions.

The raw water monitoring data will be used to compare the nitrate inputs for agricultural, residential unsewered, and residential sewered areas. In connection with local ground water flow directions the nitrate concentrations (along with associated tracer parameter data) will identify the main sources of nitrate contributing to Putnam's elevated nitrate. The measured nitrate concentrations at multiple locations will also help to remove considerable uncertainty in the modular 3-D transport model (MT3DMS) that John Kuch developed for nitrate in conjunction with the Modflow ground water flow model.

The redox conditions through the aquifer will be reviewed to determine if any portions of the aquifer are reduced and to identify the elevation of the oxidized-reduced boundary. If this boundary occurs within the vertical interval of screens of the production wells then raising or lowering this boundary will influence the nitrate concentrations of the production water.

Table 1. List of borings and planned samples

Boring Number	# Samples *	Inorganic**	Field Parameters	Isotopes	Personal Care/ Pharmaceuticals +	Filtered Sample^
1	2	Y	Y	Y		
2	2	Y	Y	Y		
3	2	Y	Y	Y		
4	2	Y	Y	Y		
5	2	Y	Y	Y		
6	3	Y	Y	Y		3
7	2	Y	Y	Y		
8	2	Y	Y	Y		
9	2	Y	Y	Y		
10	2	Y	Y	Y		
11	2	Y	Y	Y		
12	2	Y	Y	Y		
13	2	Y	Y	Y		
14	2	Y	Y	Y		
15	3	Y	Y	Y		3
16	3	Y	Y	Y	Y	3
17	3	Y	Y	Y		3
18	3	Y	Y	Y		3
19	2	Y	Y	Y		
20	2	Y	Y	Y		
21	2	Y	Y	Y		
22	2	Y	Y	Y		
23	2	Y	Y	Y		
23	2	Y	Y	Y		
24	2	Y	Y	Y		
25	3	Y	Y	Y		3
26	2	Y	Y	Y		

Y = YES

* Sample interval:
- Borings with 2 samples: 0 to 4 feet and 28-32 feet below the water table or TD – 4 feet to TD if unable to penetrate to 32 feet below the water table.
- Boring with 3 samples: 0 to 4 feet; at TD (TD – 4 feet); and mid way between the water table and TD.

** All inorganic samples will filter the cubie preserved with HNO_3 (metals)

+ Limited number of samples, but will sample 2 Putnam PWS wells

^ Samples where non-preserved and H_2SO_4 cubies are duplicated with filtered samples

4. **Sampling Frequency**
   The Geoprobe boring and sampling program is planned as a onetime sampling process. Once the samples are collected the borings will be properly abandoned.

5. **Quality Assurance Plan**
   The AGWQMP Operating Procedures Document QA/QC guidelines will be followed as closely as possible. Duplicate samples will be collected at a ratio of approximately 5 percent. Sampling equipment (pump and rods) that is reused will be cleaned and rinsed between borings. Several field/equipment blanks will be collected to evaluate the cleaning/rinse process. No trip blanks will be needed since volatile organic samples (USEPA 524.2) are not being collected. The boring samples will be collected using the AGWQMP protocols. The Geoprobe inorganic samples for metals (HNO_3 preserved cubie) will be filtered to remove turbidity.

6. **Reports to be Produced**
   DDAGW will produce a summary report that tabulates the collected data and documents the sources and concentrations of nitrate associated with different land use in the areas around Devola. It is expected that the data collected will document significant differences in nitrate concentrations associated with different land uses and septic disposal options. The report will document the sources of nitrate that appear to be creating the exceedence of the nitrate MCL at Putnam Community Water Association. Suggestion for approaches to address the nitrate sources will be proposed.

   In addition, the water table elevations and nitrate concentrations collected at various locations and depths at and below the water table may be incorporated into ground water flow models for the Devola area to significantly improve the ground water flow and nitrate transport elements of the modflow and MT3DMS models.