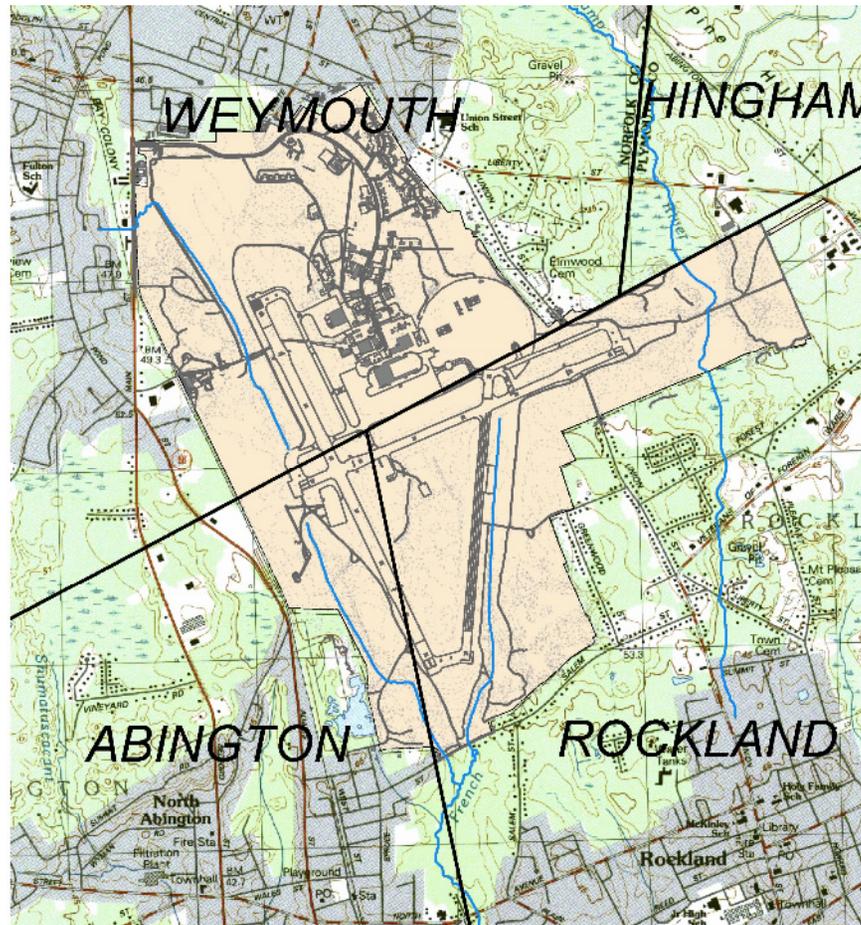


Basewide Assessment Update NAS South Weymouth Restoration Advisory Board Meeting January 11, 2007



Objective

- Update the RAB on the Navy's progress on the Basewide Assessment
- Series of Technical Memoranda
 - ❖ Basewide Hydrogeological Evaluation
 - » December 2006 (in agency review)
 - ❖ French Stream Geochemical Evaluation
 - » Floc Assessment (French Stream)
 - » January 2007 (in agency review)
 - ❖ Risk Assessments
 - » Human Health (January 2007, forthcoming)
 - » Ecological (March/April 2007)
 - French Stream
 - Higher Trophic Level Basewide

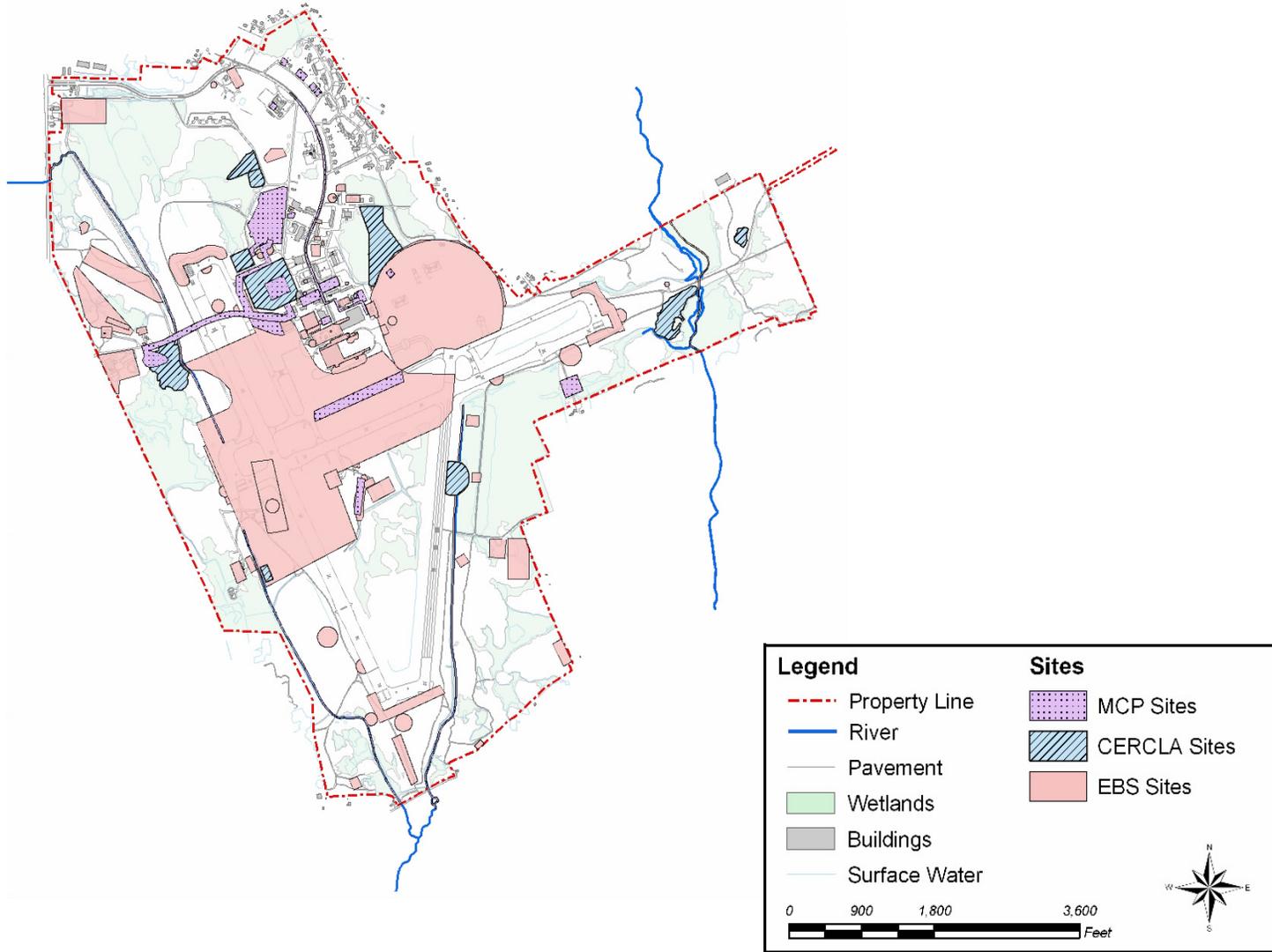


Objectives of Hydrogeologic Investigations

- Provide broader hydrogeologic interpretation to aid Conceptual Site Model (CSM) development for specific environmental sites
- Update and refine previous (2000) Basewide Groundwater Flow Assessment
- Support other Basewide investigations
 - ❖ Geochemistry Investigation



Environmental Sites at NAS South Weymouth

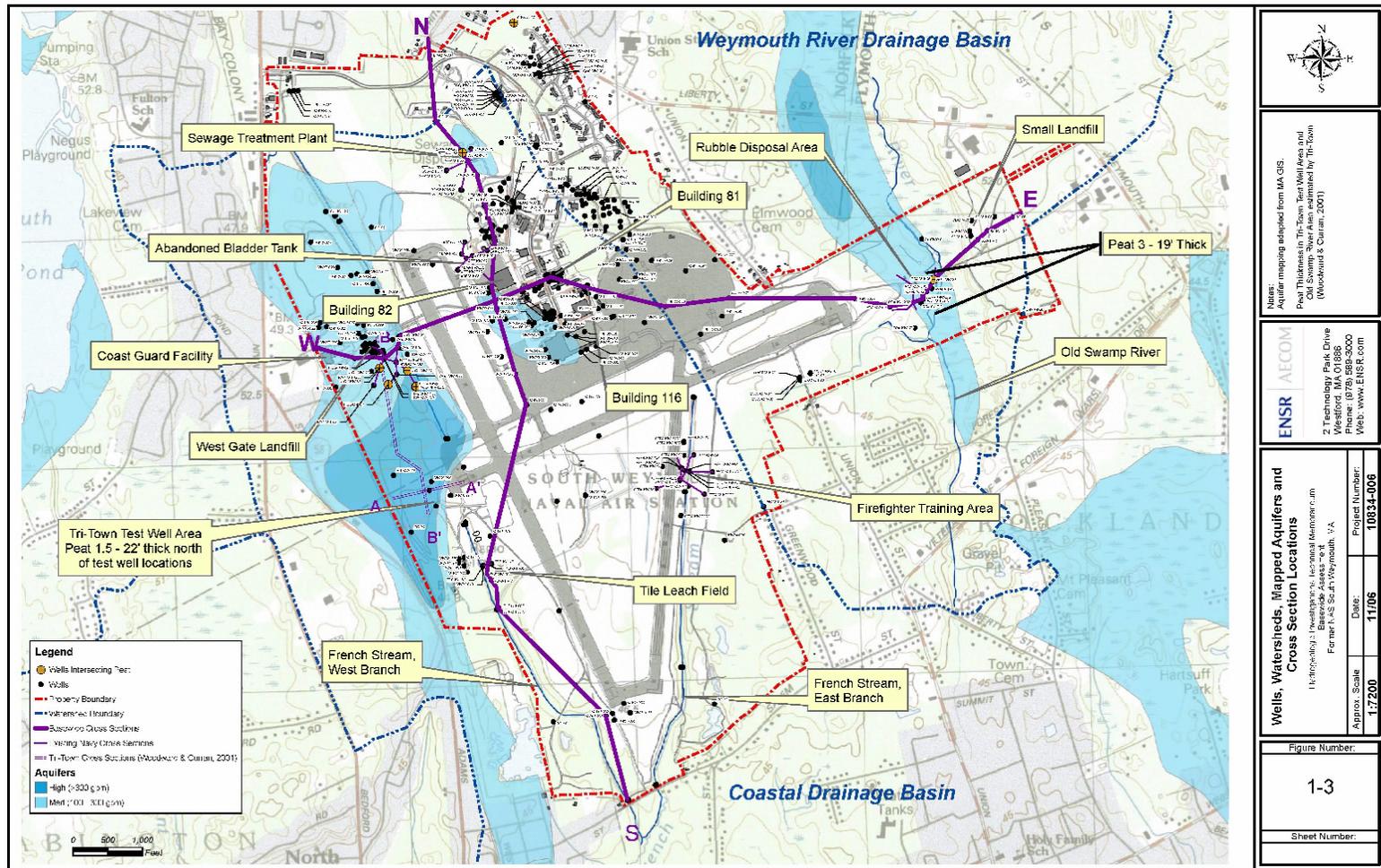


Approach for Hydrogeologic Investigations

- Compile, review, and synthesize existing data
- Limited new data gathering
- Study components:
 - ❖ Define and Characterize Hydrogeologic Units
 - ❖ Assess Potential Transmissive Zones
 - ❖ Refine Basewide Groundwater Flow Interpretation
 - ❖ Assess Historic Wetlands Filling
 - ❖ Basewide Conceptual Site Model



Wells, Watersheds, Mapped Aquifers and Cross Section Locations



North Arrow

Notes:
Aquifer mapping adapted from MA GIS.
Peat Thickness in Tri-Town Test Well Area and
Old Swamp Street Area estimated by Tri-Town
(Woodward & Curran, 2001)

ENSR AECOM
2 Technology Park Drive
Westford, MA 01886
Phone: (978) 868-3000
Web: www.ENSIR.com

**Wells, Watersheds, Mapped Aquifers and
Cross Section Locations**
1:100,000 Scale
Former I-495 South Weymouth, MA

Project Number:	10334-006
Date:	11/06
Approx. Scale:	1:7200

Figure Number: 1-3

Sheet Number:

NAS South Weymouth Hydrogeologic Units

- Analyze existing boring logs; standardize nomenclature
- Major Hydrogeologic Units:
 - ❖ Soil and Fill
 - ❖ Overburden
 - ❖ Bedrock



Soil and Fill – Unit 1

- Unit 1a: Asphalt, concrete, or other debris
 - Unit 1b: Soil or loam
 - Unit 1c: Sandy fill
 - Unit 1d: Other fill
-
- Note historic cut and fill during Base construction
 - Fill at environmental sites due to disposal or cleanup



Overburden

- Unit 2: Peat and Organic Deposits
- Unit 3: Glacio-fluvial Sand and Gravel
- Unit 4: Glacio-lacustrine Sand and Silt
- Unit 5: Sandy Upper Till
- Unit 6: Undifferentiated Till
- Unit 7: Compact Lower Till
- Unit 8: Weathered Bedrock

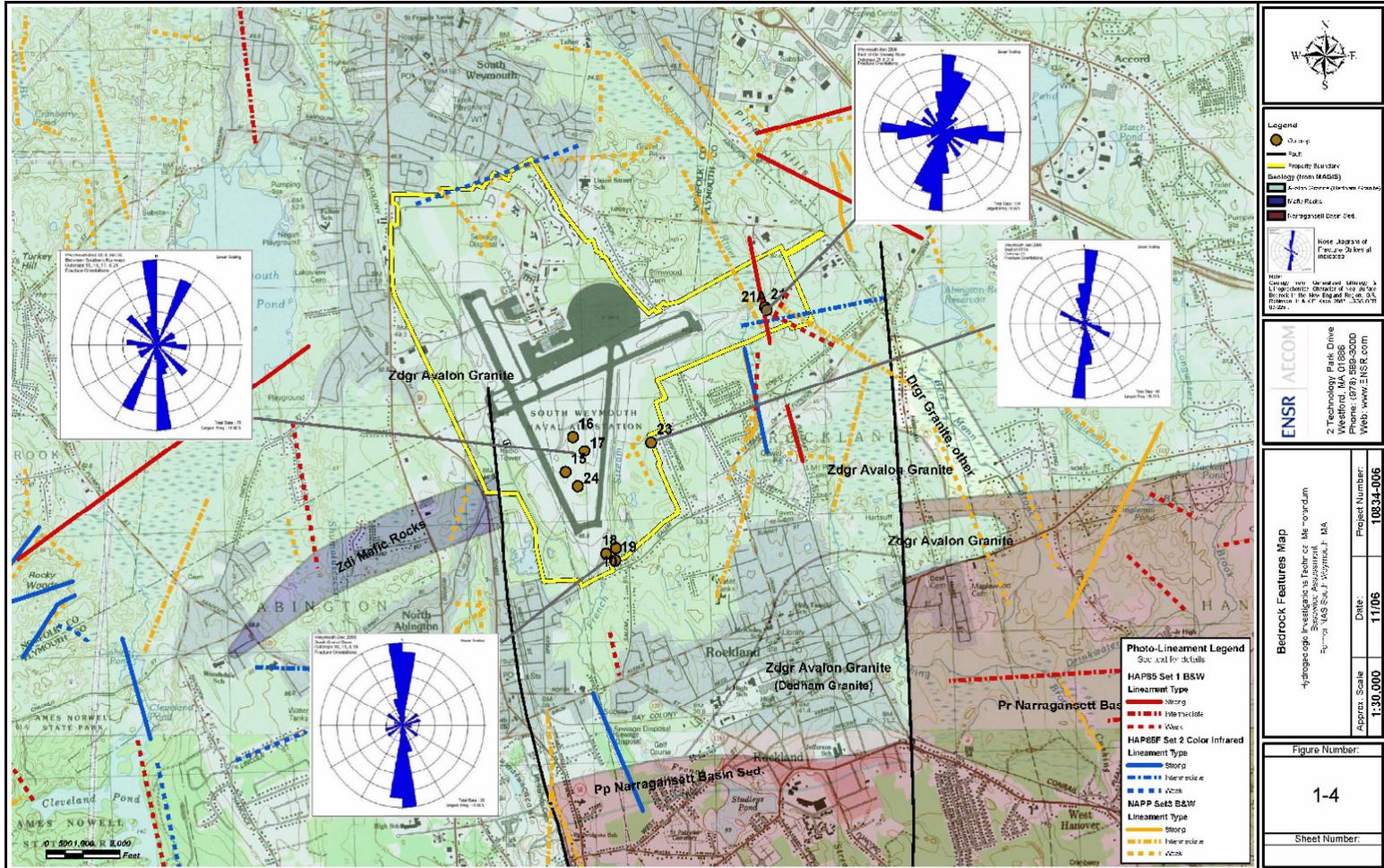


Bedrock

- Unit 9: Bedrock (Assumed based on drilling refusal)
- Unit 10: Bedrock (Observed; Dedham granite)
 - ❖ Mapped north-south fault
 - ❖ Uneven upper surface
 - ❖ Photolineaments and fractures

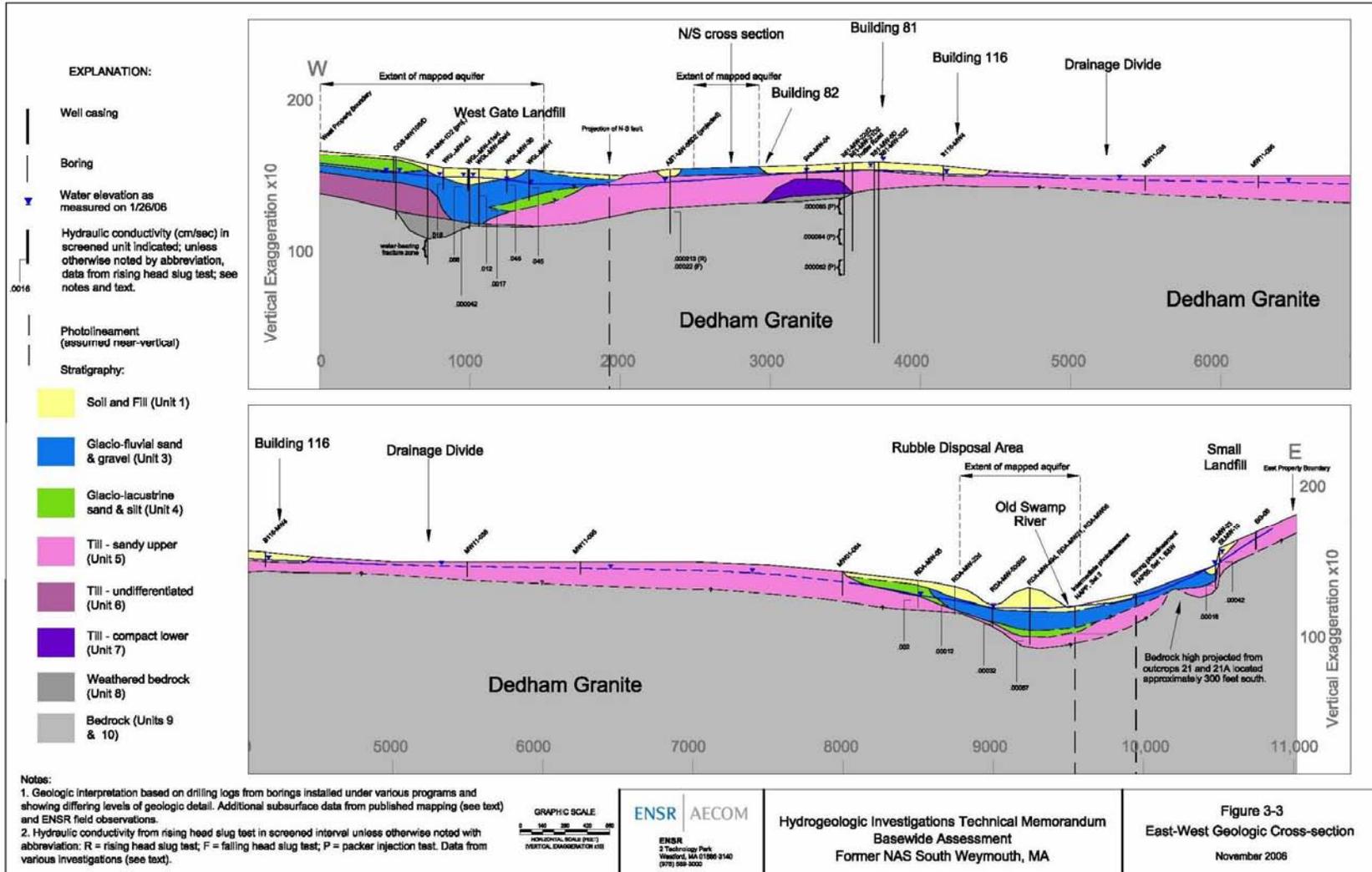


Bedrock Features



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East-West Geologic Cross-section



Groundwater Flow Assessment

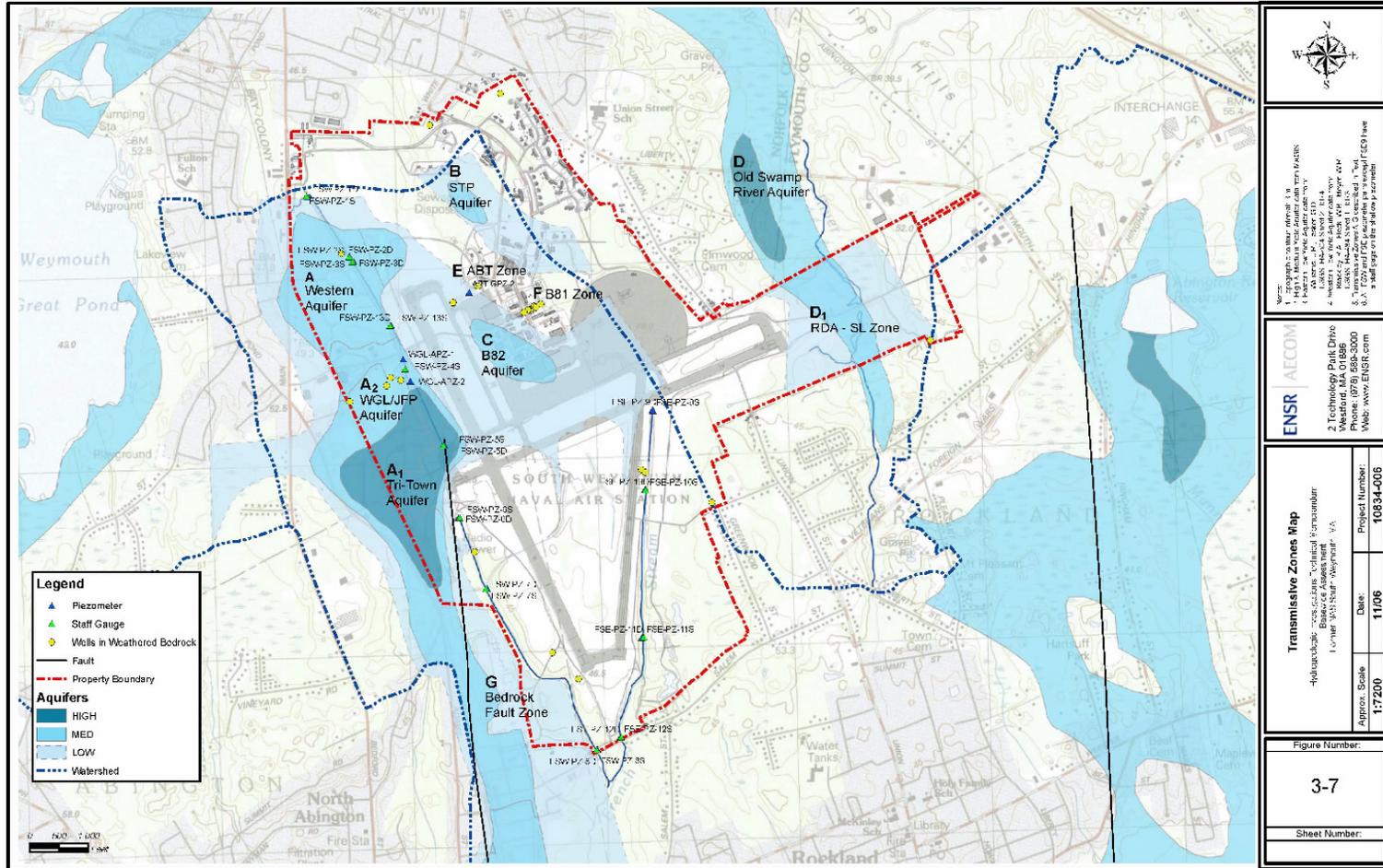
Updated evaluation includes consideration of:

- New piezometers and staff gauges in French Stream
- January 26, 2006 water level measurement (160 points)
- Tri-Town pumping test February 2006
- New survey

Two wells screened at different depths

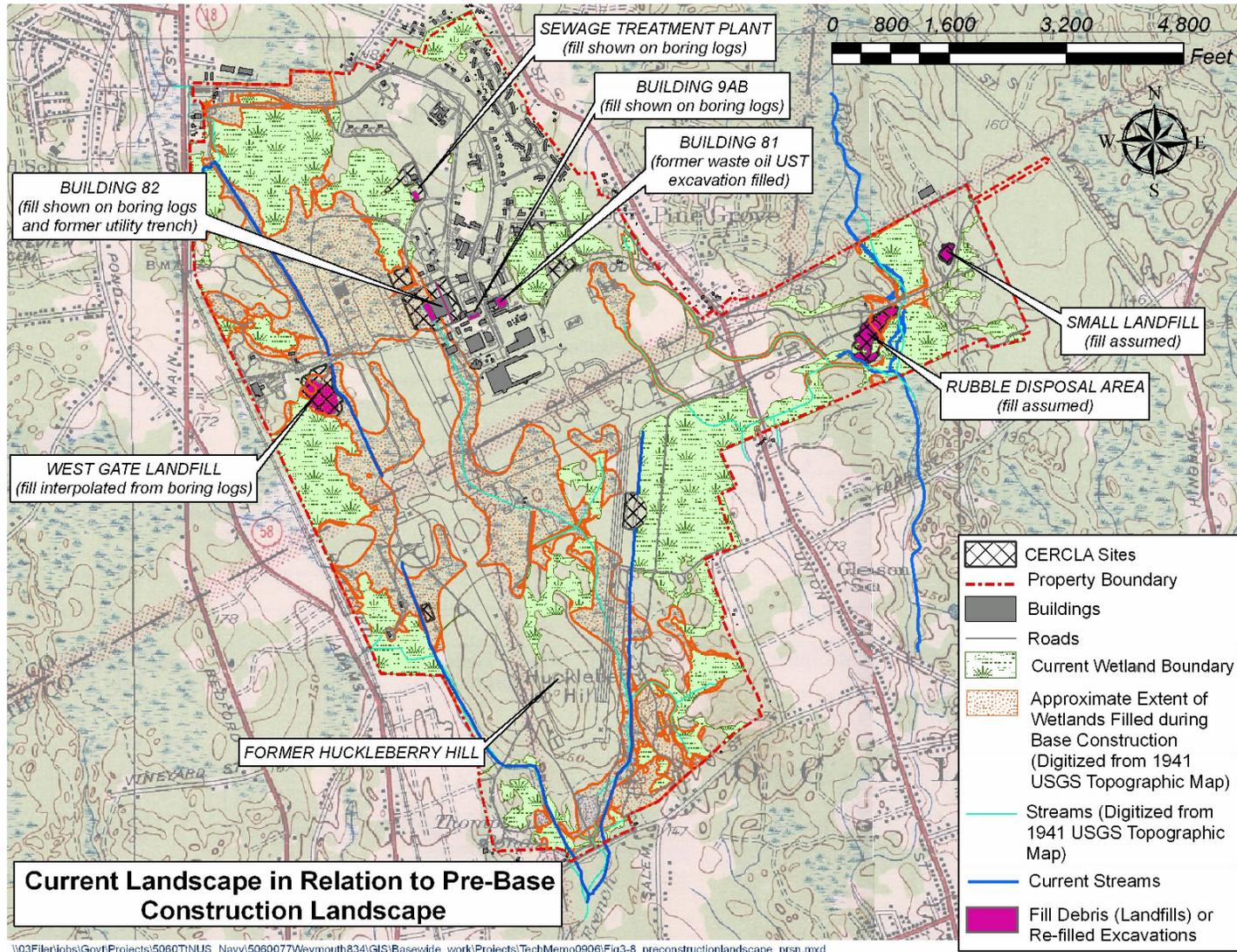


Transmissive Zones



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Conceptual Site Model (1 of 2)

- Dedham granite overlain by 0 – 50 ft of overburden and fill
- Transmissive zones include sandy fill, glaciofluvial sand and gravel, and bedrock fractures
 - Sandy till and weathered bedrock may be transmissive
- Peat, silt, compact till, and poorly fractured bedrock can restrict flow and transport
- Mapped aquifers present along French Stream, Old Swamp River, and north-central part of Base
- Most groundwater recharge from precipitation; also infiltration from surface water
- Observed groundwater levels generally shallow



Conceptual Site Model (2 of 2)

- Groundwater in overburden is unconfined
- Shallow groundwater flows toward French Stream, which is generally a “gaining” stream
- Some wetlands buried during Base construction
 - Huckleberry Hill removed during Base construction
- French Stream highly altered and channelized during Base construction



Geochemical Investigation

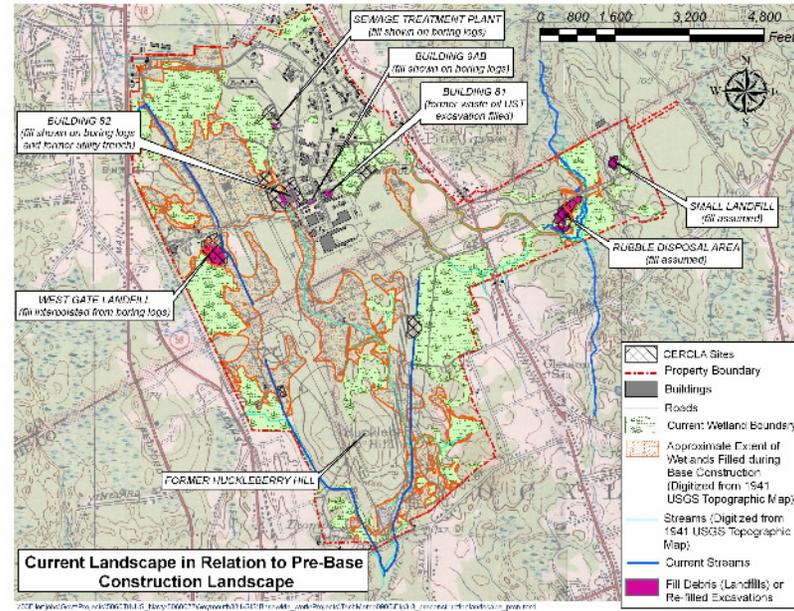
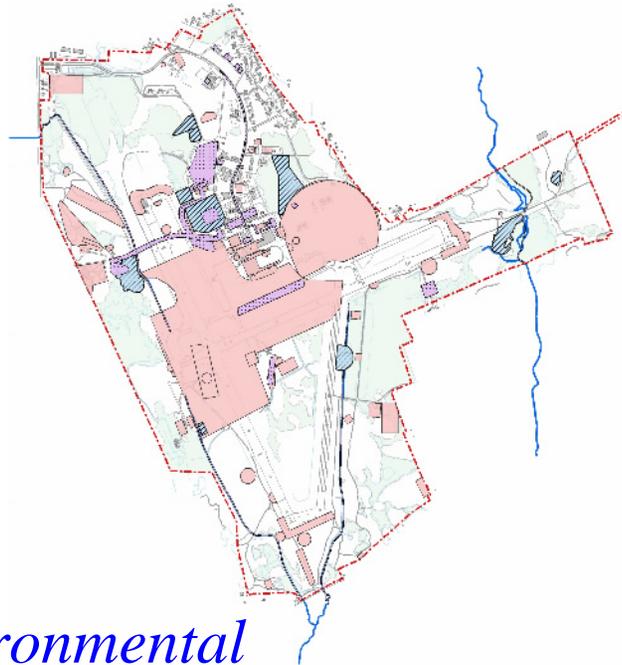


Objectives of Geochemical Investigations

- Develop and test hypotheses regarding composition, source(s), and causes of orange flocculent (floc) found in French Stream
- Evaluate whether presence of floc is related to or exacerbated by disposal activities on Site
- Evaluate alternative explanations relative to the presence of floc in French Stream



Hypothesis Testing



Environmental Sites?

Base Construction?



Bog Iron Nodule



Native Material?

Conceptual Model of Floc Formation

*Iron- and
manganese-
rich
groundwater
discharges into
slow moving
stream*

*Groundwater
mixes with
oxygenated
stream water*

*Dissolved iron and
manganese become
oxidized and
precipitate out*

*Both an iron source and
organic matter must be
present to form floc.*

*Precipitate will settle on the
streambed or be carried
downstream, often forming
clumps of orange floc*

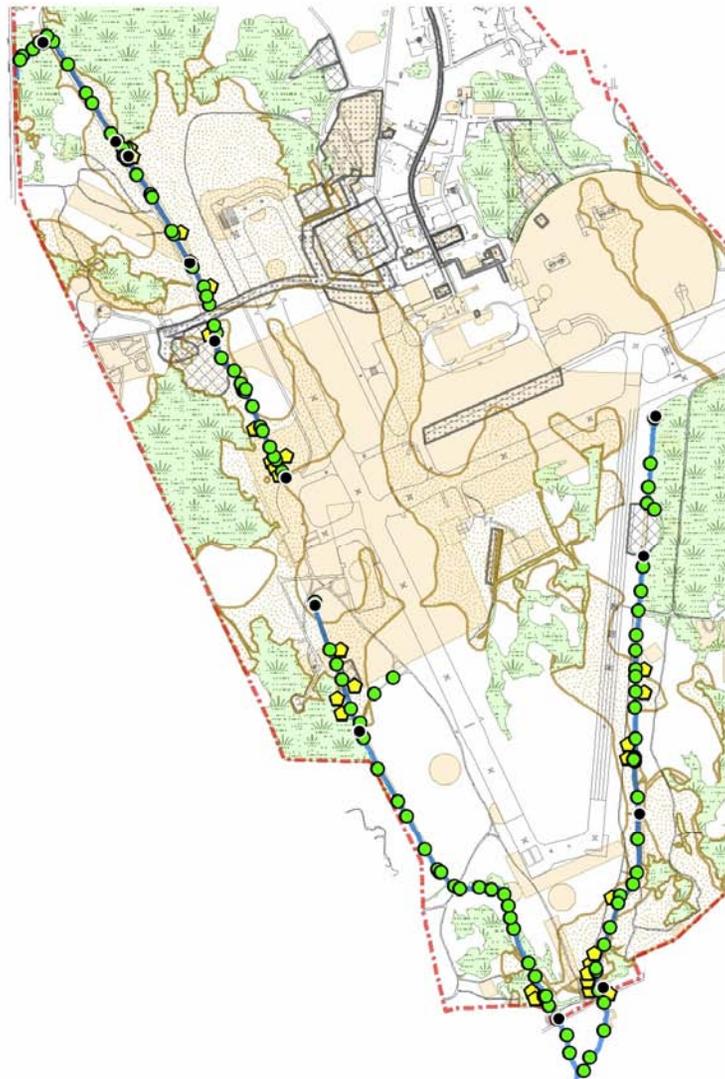


Field Effort (December 2005 – May 2006)

- Reconnaissance Surveys (61 locations)
 - ❖ Multiple field events
 - ❖ Characterize stream and map floc
- Floc Sample Collection (4 locations)
 - ❖ Bacterial and Chemical Analysis
 - ❖ Upstream/downstream evaluation at each location
- French Stream Groundwater/Surface Water Interaction (13 locations)
 - ❖ Chemistry (lab and field parameters)
 - ❖ Water Levels
 - ❖ Multiple Events



All Sample Locations 2005-2006



Legend		Environmental Sites	
	NAS Property Boundary		MCP Sites
	Roads		CERCLA Sites
	French Stream		EBS Sites
2005 and 2006 Sample Locations			
	Floc Sampling Locations		
	Piezometer Couplets (Deep and Shallow)		
	Groundwater Seeps (Mapped in March 2006)		
	Approximate Extent of Wetlands Filled during Base Construction (Digitized from 1941 USGS Topographic Map)		
	Wetland Boundary		

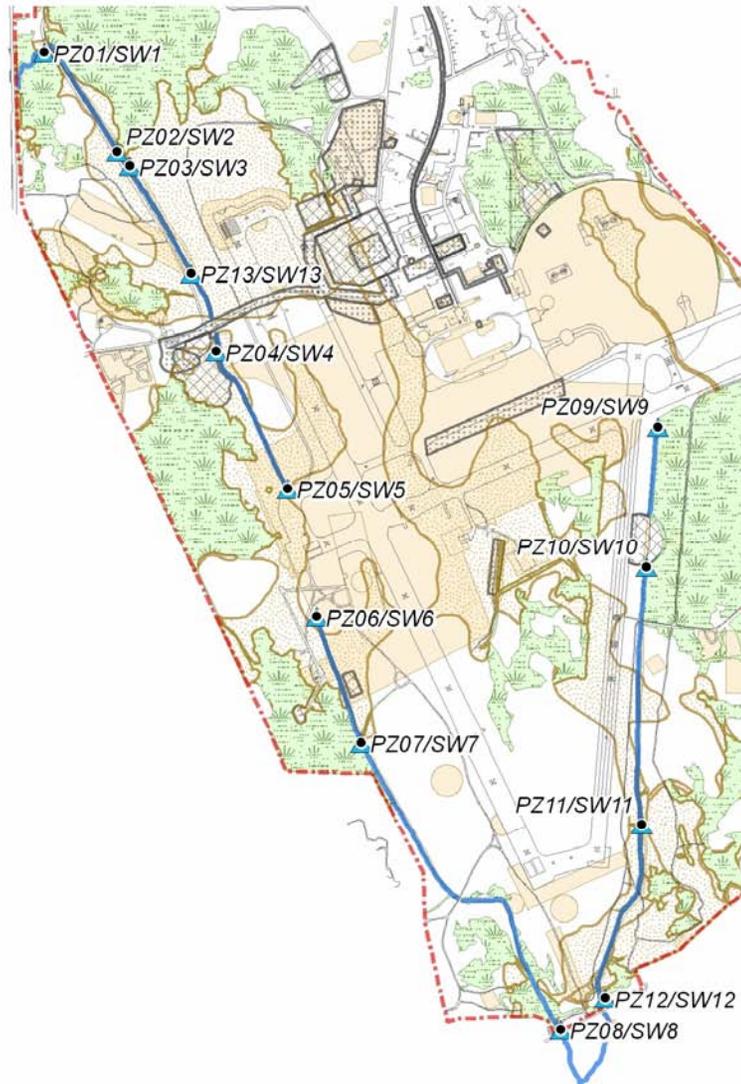


**All Sample Locations
2005 and 2006 Field Programs**
Former NAS South Weymouth
Weymouth, MA

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Piezometer Couplet Locations



Legend		Environmental Sites	
	NAS Property Boundary		MCP Sites
	Roads		CERCLA Sites
	French Stream		EBS Sites
	Piezometer Couplet Locations (Deep and Shallow)		
	Surface Water Sampling Locations		
	Approximate Extent of Wetlands Filled during Base Construction (Digitized from 1941 USGS Topographic Map)		
	Wetland Boundary		



**Piezometer Couplet Locations
(January, March and May 2006)
and Surface Water Sampling Locations**
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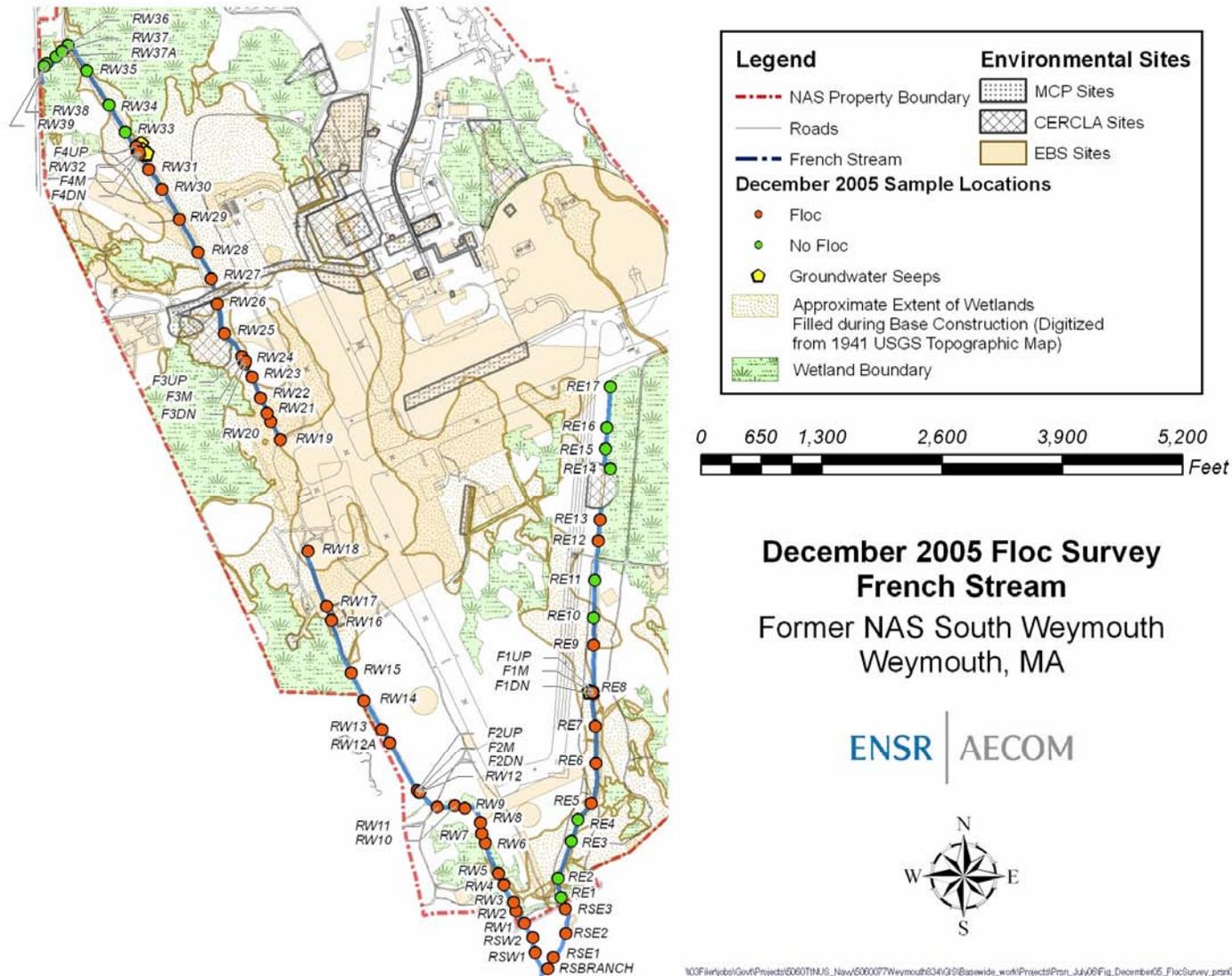


Various Floc Deposits

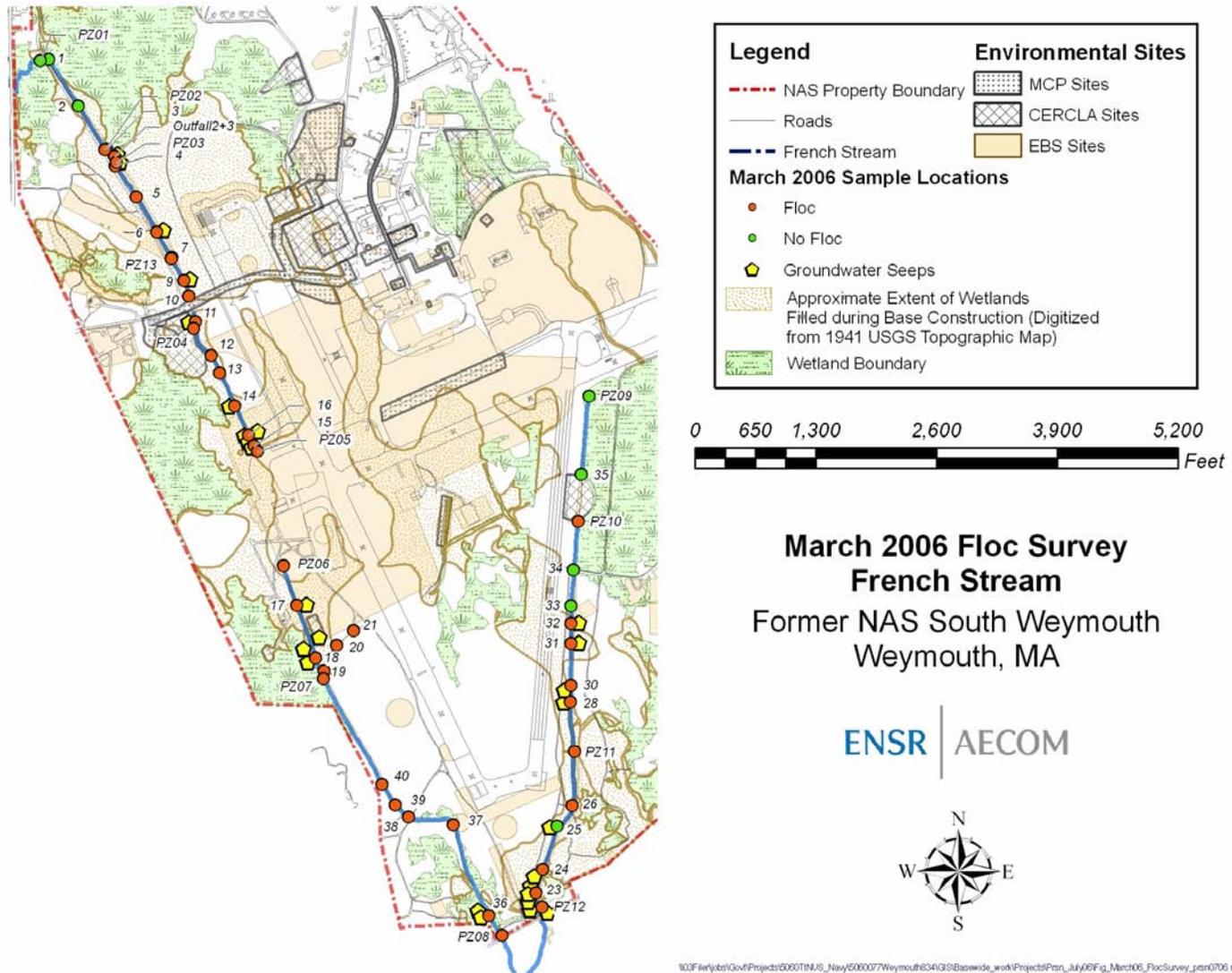


Gelatinous material located at a seep (March 2006)

December 2005 Floc Recon Results



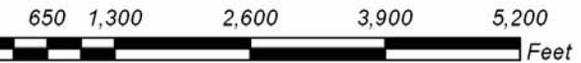
March 2006 Floc Survey Results



May 2006 Floc Recon Results



Legend		Environmental Sites	
	NAS Property Boundary		MCP Sites
	Roads		CERCLA Sites
	French Stream		EBS Sites
	Floc		
	No Floc		
	Groundwater Seeps		
	Approximate Extent of Wetlands Filled during Base Construction (Digitized from 1941 USGS Topographic Map)		
	Wetland Boundary		



May 2006 Floc Survey
French Stream
 Former NAS South Weymouth
 Weymouth, MA

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French Stream Floc

- Floc material consists primarily of iron and manganese oxides, organic matter excreted by iron bacteria, and the bacteria themselves
 - ❖ Confirmed through chemical and bacterial analyses
 - ❖ Elevated levels of certain metals found in floc
 - ❖ Bacteria found in stream are common – not specific to environmental sites or native peat deposits
 - » One septic bacteria identified at one station



USGS Sampling Results

- Concurrent study conducted by EPA/USGS
 - ❖ Observed floc at several locations along French Stream upstream of the base
 - ❖ Also observed floc at the following locations:
 - » at a swale not associated with French Stream located in the northeastern portion of the Base
 - » at one location each in the east and west branches of French Stream on the Base
 - » at three off-site downstream locations
 - one each on the east and west branches of French Stream just south of the Base property line but still on Navy property
 - two further down stream at North Street and where French Stream crosses West Water Street.



Weight-of-Evidence Conclusions

- Uncertainties associated with each of metrics evaluated complicates the evaluation
 - ❖ Collection of some types of field data in mid-winter problematic
 - ❖ Several of Navy sites are located in historically filled wetlands
 - ❖ Not possible to find ideal upstream location for comparison
 - » Several hundred acres of historically filled wetlands bisected by man-made linear channel
 - » Navy unaware of similar upstream or regional reference site
 - ❖ Stream flow and seasonal dynamics
 - ❖ Geochemical (redox) evaluations are inherently challenging
- Preponderance-of-evidence approach used to synthesize information regarding the nature, extent, and potential sources of floc in French Stream and surrounding groundwater



Weight-of-Evidence

- *Some data suggest a regional source of iron in groundwater*
 - ❖ Regional geology in and around Base is iron-rich
 - » Region has historically supported iron-based industry
 - ❖ Flocc was observed in both east and west branch of French Stream, and upstream of Base
 - » Flocc observed upstream of environmental sites
 - ❖ Flocculent bacteria are commonly occurring and not attributable to any one source
 - ❖ Groundwater that is unassociated with environmental sites has similar iron and manganese concentrations to groundwater elsewhere on Base



Weight-of-Evidence

- *Some data suggest that Base construction plays a role*
 - ❖ French Stream was channelized and more than 300 acres of wetlands were filled in as part of Base construction
 - » Fill material may have been iron-rich rock and soil
 - ❖ Peat in the sub-surface is at least partially controlling the oxygen and iron dynamics in the sub-surface
- *Some data suggest that environmental sites may also play a role*
 - ❖ It is possible that sites serve as secondary contributors of iron-rich groundwater



Geochemistry Conclusions

- Flocculent forms when water with dissolved iron moves from less to more oxidized environment
- Both iron source and organic matter in sub-surface are required to form floc
- Variety of potential sources of iron and manganese
 - ❖ Bedrock (including blast rock)
 - ❖ Soils (including wetland soils)
 - ❖ Overburden
 - ❖ Environmental Sites
- Variety of potential sources of reducing power (organic matter)
 - ❖ Filled wetlands from base construction (buried peat and organic matter)
 - ❖ Native material (peat)
 - ❖ Fill sites (not environmental sites)
 - ❖ Environmental sites (secondary)
- *Even in absence of Navy sites, a variety of natural and historical factors could potentially continue to contribute high levels of dissolved iron, resulting in floc formation in French Stream*



Schedule and Pathways Forward

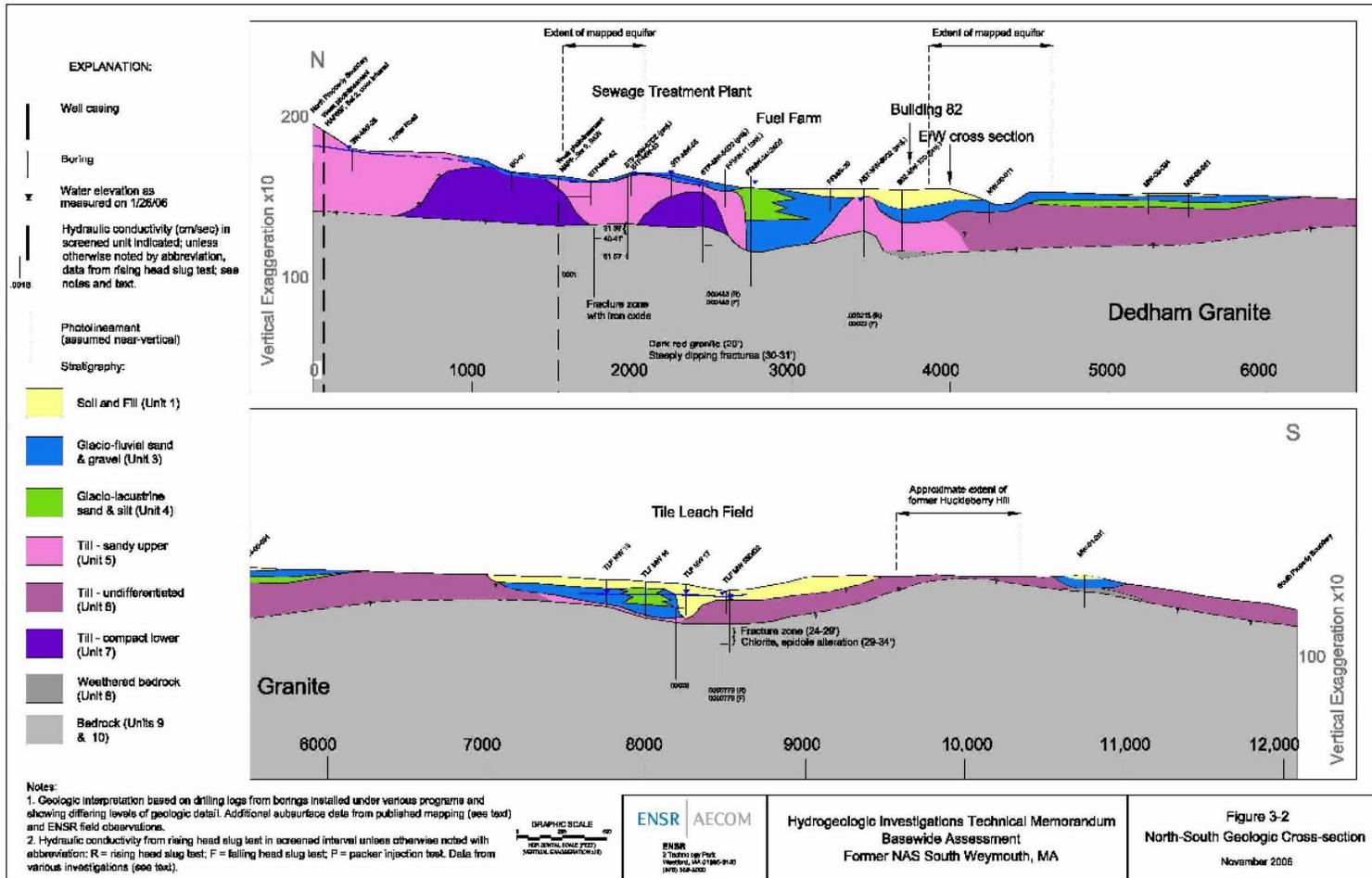
- Two Draft Technical Memoranda have been submitted to U.S. EPA and MA DEP
 - ❖ Geochemical
 - ❖ Hydrogeological
- Winter/Spring 2007
 - ❖ Human Health Risk Assessment
 - ❖ Ecological Risk Assessment
 - » French Stream
 - » Higher Trophic Level Risk



Extra Slides



North-South Geologic Cross-section



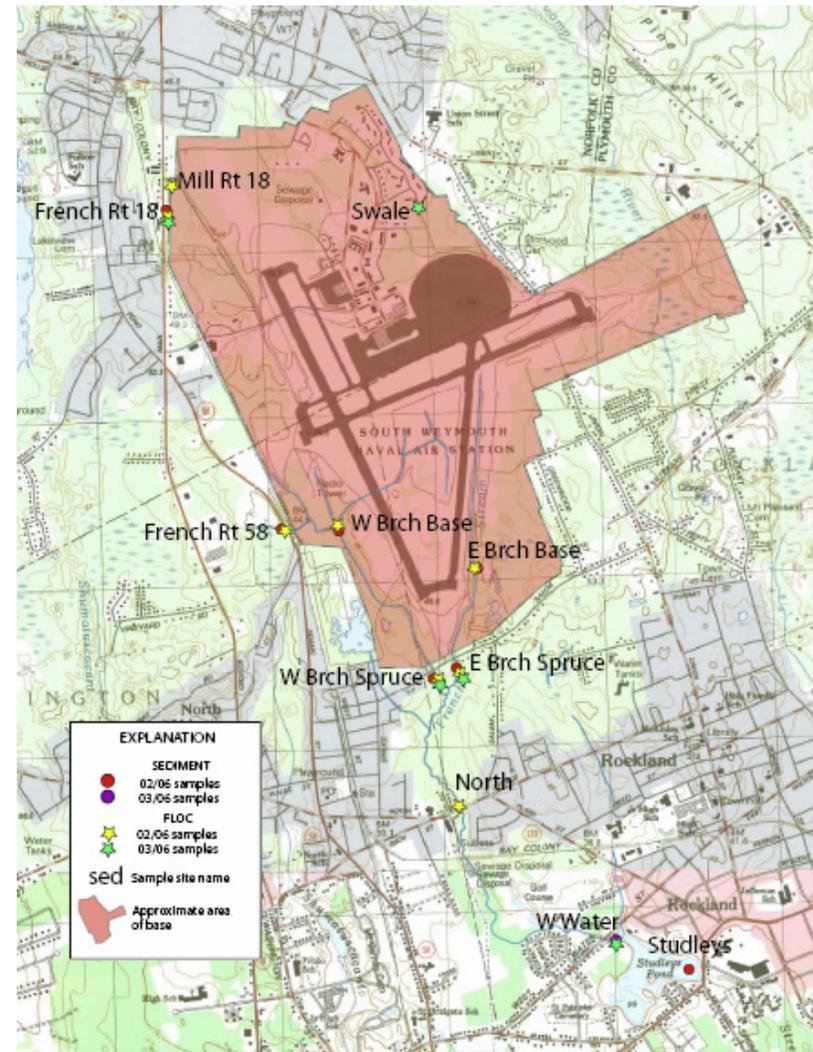
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275 Franklin Ave. Suite 200
Boston, MA 02110-2000
617-552-3000

Hydrogeologic Investigations Technical Memorandum
Basewide Assessment
Former NAS South Weymouth, MA

Figure 3-2
North-South Geologic Cross-section
November 2006

USGS Sampling Locations

- Sampling and analysis of surface water, flocculent, and sediment samples.
 - ❖ January 19, 2006, February 14-16, 2006, and March 30, 2006.
 - ❖ Within French Stream on Navy property
 - ❖ Off-site French Stream (upstream and downstream of the Base) and adjacent wetland locations.



Floc Samples for Bacteria Analysis

Location	F4 (RW-32)	F3 (RW-24)	F2 (RW-12)	F1 (RE-8)	General Occurrence	Locations Found
Floc Description	gelatinous textured	flaky orange-brown	flaky orange-brown	gelatinous, textured, orange-brown spots		
Species						
<i>Propionivibrio spp.</i>	X	X	X	X	very common	variety of environments including on human skin
<i>Zoogloea spp.</i>	X	X	X	X	not common	rivers, streams, sludge
<i>Leptothrix spp.</i>	X		X		common	groundwater and in streams
<i>Acidovorax spp.</i>			X		very common	soil, water
<i>Polaromonas spp.</i>			X		not common	rivers, streams, sludge
<i>Variovorax spp.</i>		X			moderately common	aquatic environments, soil
<i>Enterobacteriaceae</i>		X			very common	guts/intestinal tracts of animals
<i>Shigella spp.</i>		X			very common	related to Escherichia
<i>Escherichia spp.</i>		X			very common	aka e. coli, found in intestinal tracts

