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Wyandotte Neighborhood Stabilization Program: Retrofit of Two Homes

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Building Science Corporation

April 2013

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Prepared for:

The National Renewable Energy Laboratory

On behalf of the U.S. Department of Energy's Building America Program

Office of Energy Efficiency and Renewable Energy

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NREL Contract No. DE-AC36-08GO28308

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Prepared under Subcontract No. KNDJ-0-40337-00

April 2013

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Definitions

ACCA	Air Conditioning Contractors of America
AMI	Area Median Income
ASHP	Air Source Heat Pump
BA	Building America Program. More information about BA can be found at www.buildingamerica.gov
BEopt	Building Energy Optimization Program – House energy simulation program and primary analysis tool for Building America homes.
BSC	Building Science Corporation. More information about BSC can be found at www.buildingscience.com
ccSPF	Closed-cell Spray Polyurethane Foam
ocSPF	Open-cell Spray Polyurethane Foam
CFIS	Central Fan Integrated Supply, a mechanical ventilation design. More information about CFIS ventilation can be found at www.fancycler.com/
EF	Energy Factor
FF PIC	Foil Faced Polyisocyanurate
GSHP	Ground Source Heat Pump
HSP	House Simulation Protocol – Guideline document that defines the benchmark, a standard calculation by which the retrofit construction test house is compared.
IECC	International Energy Conservation Code. More information can be found at www.energycodes.gov/
MSHDA	Michigan State Housing Development Authority
NREL	National Renewable Energy Labs. More information about NREL can be found at www.nrel.gov/
NSP2	Neighborhood Stabilization Program 2 (NSP2) more information can be found at www.hud.gov/offices/cpd/communitydevelopment/programs/neighborhoodspg/arrafactsheet.cfm
o.c.	On Center
OSB	Oriented Strand Board
pcf	Pounds per cubic foot
ocSPF	Open-cell Spray Polyurethane Foam
SEER	Seasonal Energy Efficiency Ratio
SIR	Savings to Investment Ratio

Executive Summary

The Wyandotte Neighborhood Stabilization Program 2 (NSP2) project is building 20 new houses and retrofit 20 existing houses in Wyandotte, Michigan. This report details the retrofit of two existing houses in the program. Wyandotte is part of a Michigan State Housing Development Authority (MSHDA)-led consortium that is funded by the U.S. Department of Housing and Urban Development (HUD) under the NSP2 program. The City of Wyandotte has also been awarded U.S. Department of Energy (DOE) energy efficiency and conservation block grant (EE&CBG) funds that are being used to develop a district ground source heat pump (GSHP) system to service the project.

This report examines the energy efficiency recommendations for retrofit construction at these homes. The report will be of interest to anyone planning an affordable, high performance retrofit of an existing home in a cold climate zone. Information from this report will also be useful to retrofit or weatherization program staff, as some of the proposed retrofit solutions will apply to a wide range of projects.

In this project, the DOE Building America team Building Science Corporation (BSC) addressed the following research goals and questions on the two test houses:

1. Does the ccSPF retrofit insulation strategy provide the planned level of airtightness in the existing building frame?
2. Where insulating sheathing is used with replacement windows, can water management details for insulating sheathing be cost effectively executed by the construction team?
3. Does the total project cost fall within the project requirements and deliver higher than expected energy performance?
4. Is the sizing method for the GSHP accurate for small houses with high thermal resistance enclosures?
5. Can the GSHP unit be reduced in size to accommodate additional homes on the same well?

Results from the first complete house suggest that the technology package employed (which includes spray foam insulation and insulation sheathing) does meet the specific whole house water, air, and thermal control performance specification established for this project and the project's affordability goals. The technology specification for the existing NSP2 houses has achieved an estimated 42% reduction in whole house energy use relative to the Building America Benchmark. Monitoring of the GSHP system has been recommended for a future project. Future collection of utility bill data is planned..

1 Introduction

This research report describes work conducted by Building Science Corporation (BSC), a U.S. Department of Energy (DOE) Building America research team and describes a project to retrofit two single family homes as part of the Wyandotte, Michigan Neighborhood Stabilization Project 2 (NSP2).

Through the test home evaluation in Wyandotte, BSC has acquired important information about the construction and performance of the energy efficient technology packages designed for U.S. Department of Housing and Urban Design (HUD) NSP2 retrofit projects in a cold climate. This research addresses the following gaps and barriers:

- Affordable high performance enclosure assemblies
- Complete high performance technology packages for affordable homes.

Through this work, BSC has also collected information about the cost and implementation issues with high R-value assemblies in existing buildings. In the future, BSC will use this project to collect measured energy use data for affordable high performance retrofits.

1.1 Project Background

The Wyandotte NSP2 project is building 20 new houses and retrofit 20 existing houses in Wyandotte, Michigan. Wyandotte is part of a Michigan State Housing Development Authority-led consortium that is funded by HUD under the NSP2 program.[1] The City of Wyandotte has also been awarded DOE energy efficiency and conservation block grant (EE&CBG) funds that are being used to develop a district GSHP system to service the project.[2]

The first two existing houses constructed in this NSP2 project were selected as part of the Building America research project, and are shown in Table 1 below. Both houses were poorly maintained and near the end of their useful service life. The retrofit work for these houses included complete interior renovation and upgrades to the enclosure and mechanical systems. It is expected that this investment has significantly extended the service life of these buildings.

[1] Information about the MSHDA program can be found here: http://www.michigan.gov/mshda/0,1607,7-141--217713--,00.html

[2] More information about the DOE EE&CBG grant can be found here: http://www.energy.gov/9068.htm

Table 1. Wyandotte NSP2 Test Houses

	Cedar 1 1453 ft^2 two-story single-family detached house
	Cedar 2 1327 ft^2 one-and-a-half-story single-family detached house

Figure 1 below shows typical houses in the NSP2 neighborhood.

Figure 1. Typical existing houses in the NSP2 neighborhood

Research work undertaken by Building Science Corporation on this project is connected to previous research work on high R-value retrofit enclosures, the effectiveness of ventilation systems, and other whole house energy efficiency retrofit packages for affordable housing as described below.

High performance retrofit wall assemblies have been studied and reported on by BSC [Pettit 2009; BSC 2011-2, 2011-3] and research work on this technology continues. Findings indicate

that an existing wood frame wall can be effectively retrofit from either the exterior (with board foam insulation or spray foam insulation) or from the interior (with a variety of insulation materials). A recent BSC paper has summarized the experience with these efforts [Ueno 2010] and identified water management and air tightness issues as major concerns for both methods. For air sealing, complicated building geometry will be identified early and particular attention will be paid to the insulation and air barrier retrofit in these areas. Spray foam insulation applied from either the interior or the exterior will be an initial system for consideration based on past success. Simplification of the existing house geometry through use of a "chainsaw retrofit" will also be considered [Orr 1987]. Research work on this project will extend BSC's past work with water management and air barrier details for high thermal performance retrofit enclosures.

The planned NSP2 retrofit package (Table 2 below) draws on whole house energy efficiency research work that has been published by BSC in the Builder's Field Guides series [Lstiburek 2006]. In particular, the affordability aspects of the NSP2 package draw upon past cold climate research work with Habitat for Humanity [BSC 2010/02] and other community builders [BSC 1999, BSC 2008].

In Table 2, the "NSP2 Final Specifications" column on the left shows the target post-retrofit specification. The "Existing Building" column on the right shows the pre-retrofit conditions for both test houses.

Table 2. Summary of Wyandotte NSP2 Energy Efficiency Retrofit Package Components

	NSP2 Final Specifications	Existing Building
Building Enclosure		
Roof	R-50 Unvented cathedralized attic 8" ccSPF insulation	Uninsulated
Walls	R-23 Hybrid insulation walls 1" XPS insulating sheathing (R5), 3" ccSPF to inside of wall sheathing (R18)	Uninsulated
Basement Floors	Uninsulated	Uninsulated
Basement Walls	R13 Full-height interior insulation 2" PIC insulation (R13)	Uninsulated
Windows	Above grade: Vinyl double glazed (U=0.32, SHGC=0.32) Basement: glass block windows (U=0.6, SHGC=0.6)	Single glazed (U=0.87, SHGC=0.62)
Infiltration	2.2 ACH50	Greater than 15 ACH50
Mechanical Systems		
Heating	GSHP 3.7 COP	78% Gas furnace
Cooling	GSHP 3.7 COP	10 SEER air source heat pump
DHW	0.94 EF electric tank water heater	0.86 EF electric tank water heater
Ducts	All ducts in conditioned space	R-6 ductwork in attic, 15%

	NSP2 Final Specifications	Existing Building
		total leakage
Ventilation	CFIS supply-only as per ASHRAE 62.2	No ventilation
Appliances and Lighting		
Lighting	100% fluorescent	33% fluorescent
Appliances	ENERGY STAR appliances	Standard appliances

Appendix F includes contact information for team members who are involved in the project.

1.2 Relevance to Building America Goals

Overall, the goal of the DOE Building America program is to "reduce home energy use by 30%-50% (compared to 2009 energy codes for new homes and pre-retrofit energy use for existing homes)." To this end, the Building America research teams conduct research to "develop market-ready energy solutions that improve efficiency of new and existing homes in each U.S. climate zone, while increasing comfort, safety, and durability."[3]

The technology package that will be developed through this research task is intended to be suitable for a range of single-family or attached houses with basements. Further characterization of target houses will be done as part of the selection process for additional test houses within this task. The information gained through this research will support widespread deployment of this package in existing housing across the cold climate zone.

The most immediate impact of the research project will be to inform the work of the twelve Michigan municipalities that are part of the Michigan NSP2 Consortium, including: Detroit, Highland Park, Hamtramck, Wyandotte, Flint, Saginaw, Pontiac, Lansing, Battle Creek, Kalamazoo, Grand Rapids, and Benton Harbor. The Consortium has received approximately $224 million in funding from HUD for redevelopment of blighted and vacant land within the participating communities (see Figure 2 below). Looking at "Use B"—the funding for the renovation of existing houses—BSC estimates that the research work with Wyandotte will affect the retrofit of more than 600 existing Michigan homes within the first round of NSP2 development and likely many additional homes in subsequent rounds of development as the sales revenue from the project is redeployed.

[3] http://www1.eere.energy.gov/buildings/building_america/program_goals.html

Target Market	NSP2 Funds	% of Requested NSP2 Funds
Administration	$26,350,000	10%
Use A - Financing Mechanisms	$13,175,000	5%
Use B - Purchase and rehab of abandoned or foreclosed upon homes and residential properties to sell, rent or redevelop	$105,400,000	40%
Use C - Land Bank Acquisitions & Management of Foreclosed Residential Properties	$26,350,000	10%
Use D - Demolition Blighted Structures	$65,875,000	25%
Use E - Redevelop demolished or vacant properties	$26,350,000	10%
Total:	$263,500,000	100%

Figure 2. Proposed NSP2 allocations by eligible use (MSHDA 2009)

The project also has the potential to impact Building America measure guidelines on high R-value enclosure retrofits for walls, roofs, and foundations for cold climates, as well as guidance on GSHPs for retrofit applications. The Wyandotte, Michigan, NSP2 retrofit test homes may also provide an opportunity for long-term research on GSHP performance and the performance of GSHP systems in shared-well installations and at a community-scale installation.

1.3 Project Location

All of the construction for this project will be done in the NSP2 neighborhood in Wyandotte. (see Table 3 and Appendix A). As the project progresses, specific property addresses will be drawn from a pre-selected inventory of vacant or foreclosed properties. Table 3 lists the houses by unit type (property addresses are not reported) and shows how the construction of the houses will be tendered in sequence for construction.

Table 3. Wyandotte NSP2 Properties by Bid Package

NSP2 Bid Pack 1				
Item	**New Address**		**Type**	**Style**
1	Cedar 1[a]		Existing	1½ story
2	Walnut 1[b]		New Design	1½ story
3	Walnut 2[b]		New Design	1½ story

NSP2 Bid Pack 2				
Item	**New Address**		**Type**	**Style**
1	Vinewood 1[b]		New Modified	1½ story
2	Poplar 1[b]		New Modified	1½ story
3	Cora 3[b]		New Design	1½ story
4	Cora 4[b]		New Design	Ranch
5	Cora 1[b]		New Design	Ranch
6	Cora 2		New Modified	1 1/2 story
7	Cedar 2[a]		Existing	1 1/2 story

NSP2 Bid Pack 4				
Item	**New Address**		**Type**	**Style**
1	Poplar 2[b]		TBD	TBD
2	Vinewood 2[a]		TBD	TBD
3	Poplar 3		TBD	TBD
4	Cora 5[b]		TBD	TBD
5	Cora 6		TBD	TBD
6	Poplar 4		TBD	TBD
7	Poplar 5		TBD	TBD

[a] These houses have been included in BSC's TO2 8.5 project.
[b] These houses have been included in BSC's TO2 4.3 project.

Figure 3 shows the proximity of Wyandotte, Michigan to Detroit.

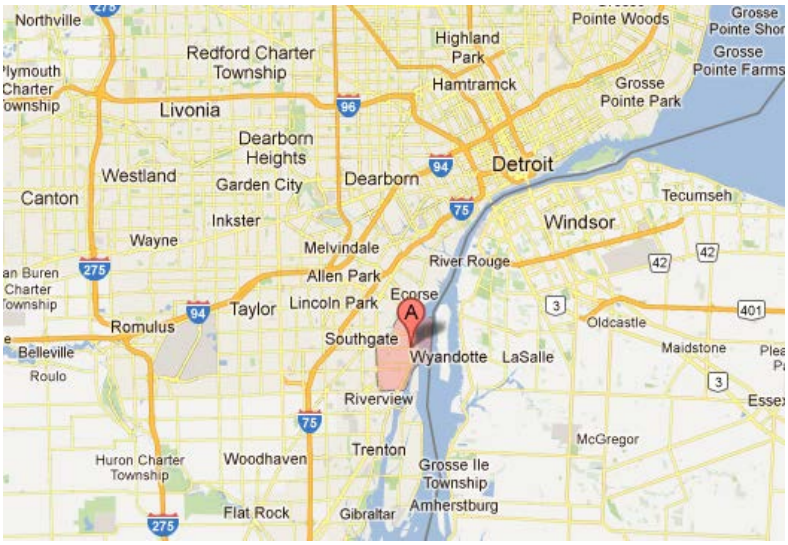

Figure 3. Wyandotte, Michigan relative to Detroit

2 Mathematical and Modeling Methods

2.1 Energy Modeling Methods

BSC analyzed the initial drawings provided by the design team to establish the level of energy efficiency that the as-designed, retrofit homes were likely to achieve. This was followed by BSC analysis to determine measures needed to achieve energy target levels; the development of recommendations for moisture control, durability, and indoor air quality improvements; and the discussion of relevant construction details with the design and construction team.

BSC utilized a systems engineering approach, which looks at the performance of the house as a whole rather than only focusing on the building elements related to specific disciplines. Recommended improvements were considered due to their benefit for multiple subsystems in the home and for their benefit to the overall house performance. While energy is the most important driver for improvement in Building America research, other vital attributes were considered, including sustainability, durability, comfort and indoor air quality.

The energy analysis is presented below as a parametric study. The overall energy reduction is broken down into incremental changes to show what impact a specific improvement has on overall performance (i.e., “How much energy does this house save from upgrading my windows?”). This portion of the research work involved continuous back and forth correspondence with the design team, including discussions on the feasibility of incorporating various measures into the builder's practices, and the cost implications.

Whole house hourly energy simulations were completed calculating the source energy consumption savings for the target house compared to the 2010 Building America Benchmark definition created by DOE [Hendron and Engebrecht 2010]. An explanation of site and source energy can be found in Building Science Digest 151: Understanding Primary/Source and Site Energy at http://www.buildingscience.com/documents/digests/bsd151-understanding-primary-source-site-energy

The following tools were used:

- Energy modeling through computer simulations (including BEopt) to predict the energy savings of the home – This analysis is performed on all Building America homes so that a percent energy savings is calculated.
- HVAC design (Manual J8 heating and cooling load calculation, equipment sizing, and duct layouts)

3 Experimental Methods

3.1 Testing Methods

Both test homes were performance tested by a local HERS rater employed by the City of Wyandotte and BSC. The performance testing is intended to confirm that the house meets the energy efficiency specification of the technology package, including the following:.

1. Blower door test to measure the house infiltration rate before and after retrofit work
2. Duct pressurization test to measure duct leakage (both total duct leakage and duct leakage to outside)
3. Outside air ventilation rate measurement
4. Register flow measurement (to ensure proper airflow from each supply register)
5. HVAC equipment static pressures (measures steady state operation of air handler equipment)
6. Bedroom-to-hallway pressure difference while door is closed (to ensure that transfer grille or jump ducts was sized properly such that room pressurization can be prevented when the door is closed)

Indoor temperature and relative humidity have also been measured during site visits, and long-term logging of these conditions may be done pending agreements with the homeowners. If implemented, these measurements will continue into 2013.
The analysis of the building performance testing will include conversion of the CFM 50 blower door result to additional units of infiltration rates. Below is the equation for converting a CFM 50 result to Air Changes per hour at 50 Pascals:

$$ACH_{50} = [\text{CFM 50} / \text{conditioned volume (cf)}] * 60$$

The BSC team compared duct pressurization test results between the two test homes, both total and duct leak to outside, and measured outside air to confirm proper ventilation rates. The team also measured register CFM and air handler static pressures as part of the HVAC commissioning process, and compared the individual register CFM flows to the Manual J8 design flows.

In addition to the information described above, BSC will collect basic long-term data on the GSHP operation by Wyandotte Municipal Services, the public utility that is owned by the City of Wyandotte. The data will not be analyzed by this research project but would be available for use by a future research project.

3.2 Collection of Utility Bill Data

For the Wyandotte retrofit project, the City of Wyandotte will collect monthly utility bill data for each retrofit home and, if possible, for similar new or existing houses in the NSP2 project area. The utility bills will include the monthly dollar amount, units of energy used (e.g., therms of gas, kilowatt-hours electricity, gallons propane), and floor plan type. The study period is typically two or three years following construction. BSC will analyze the data on a semi-annual basis and provide a report to all research partners.

For this project, the collection of utility bill data is the responsibility of the City of Wyandotte. For each NSP2 house, a release form signed by the new homeowner will be collected at the time of sale. The City of Wyandotte has proposed that this be included in the purchase agreement for each house. Homeowners will be given an explanation of the Building America program, the goals and objectives for the Wyandotte project, and a statement of how the data will be used. Where possible, the data will be connected to post-retrofit performance, but because of the City's ownership of the house, this does not need to be connected to a particular homeowner—i.e., the data can be anonymous.

A complete analysis of the data also requires collection from a matching group of houses that are built to "normal" standards. For Wyandotte, this may involve recruiting participants from existing houses in the neighborhood given that the City-owned utility is the provider of electricity for all houses in Wyandotte. Some houses in Wyandotte have gas service, and a separate arrangement will need to be made in order to secure the full participation of existing houses in the area. Although firm plans have not been made at this time, study of the whole house energy use on this scale would also fit well with the City's plan to build a GSHP-based district system by providing solid information about how existing houses in the area use energy compared to the new houses built or renovated to a higher performance standard. The City may, in fact, already have collected this information, and they are investigating this possibility.

4 Results

This section of the report details the results of:

- The work to refine the energy efficiency technology package for the project (including the enclosure and mechanical specifications)
- The energy analysis of the package (including the cost effectiveness of the selected measures)
- The performance testing of the completed houses.

4.1 Final Energy Efficient Technology Package

BSC conducted initial energy analysis as a starting point for the development of the final package; see Appendix B for this analysis. The following section describes the final package of energy efficient technology that BSC developed for the Wyandotte, NSP2 program, based on discussions with City of Wyandotte staff (including Building Department officials) and the project architect. As part of these discussions, BSC performed analysis of the enclosure and mechanical energy efficient technology specification.

This project included constraints that affected the selection of energy efficient technology. The most significant one was the choice to use GSHP systems for heating and cooling for all NSP2 program houses. The City of Wyandotte chose to use GSHP systems early in the project as part of a strategy to introduce green technology into the City-owned utility's portfolio. The long-term vision for Wyandotte is the creation of a district system that will start with the NSP2 neighborhood and then expand to service the remaining city center areas. The supply and installation of the GSHP systems and wells was contracted for by the City before the housing program was started. Therefore, the individual houses examined by this energy analysis started with the GSHP as a fixed element of the technology package—constraining both system choice and total cost.

The proposed construction technology was also intended to be compatible with the technology traditionally employed by trades in the Wyandotte area. This limited the selection of enclosure systems but was compatible with the proposed high thermal resistance hybrid wall recommended by BSC.

Figure 4. Photograph of Cedar 1 near completion

4.1.1 Enclosure Specifications

The enclosure specification for both test houses is summarized in Table 4 below.

Table 4. Wyandotte, Michigan NSP2 Retrofit Enclosure Specifications

Enclosure	Specifications
Ceiling Description	Dark color asphalt shingles on rafter roof – unvented cathedralized attic
Insulation	8 in. (R-50) ccSPF on underside of roof
Walls Description	Hybrid wall with insulating sheathing and spray foam
Insulation	1 in. (R-5) XPS sheathing, 3 in. (R-18) ccSPF in cavity
Foundation Description	Conditioned basement/crawlspace
Insulation	2 in. XPS (R-10) on walls or 2 in. (R-12) ccSPF
Windows Description	Double pane vinyl framed with LoE^3 spectrally selective glazing
Manufacturer	Anderson
U-value	U = 0.32
SHGC	SHGC = 0.32
Infiltration	
Specification	2.5 in.^{2} leakage area per 100 ft^2 enclosure @ 50 Pa
Performance Test	Initial test result = 2.0 in.^{2} leakage area per 100 ft^2 enclosure @ 50 Pa

4.1.1.1 Roof

A variety of enclosure assemblies could be employed for the roofs in the NSP2 retrofit houses. The selected assembly for both test houses is a cathedralized, unvented attic that employs approximately 8 in. of 2.0 pcf ccSPF sprayed to the underside (interior) of the roof sheathing in the rafter cavity. This allows for the kneewall spaces to be used for ductwork distribution and generous storage areas for the homeowner. In the Cedar 1 house, the existing shingles were recently installed and were not replaced.

For other, future existing houses in the NSP2 program, there may be an opportunity to use a cheaper vented roof assembly. In these roofs, cellulose insulation would be installed on the ceiling plane. Many of the houses have sloped ceilings on the second floor with a combination of kneewall and above collar tie spaces. These houses would be insulated in the same way, but vented and completeness of the insulation and air sealing will need to be examined on a case-by-case basis.

4.1.1.2 Walls

The above-grade structure of the houses is typically 2 × 4 construction with board sheathing. For both houses, the approach was to strip the existing cladding and then reclad from the exterior with 1 in. of XPS insulating sheathing and a new drainage plane. The exterior surface of the insulating sheathing is taped with sheathing tape and integrated with windows, doors and other penetrations to form a drainage plane. A variety of claddings are used in the architectural plans for each house, but vinyl siding direct applied over the face of the insulating sheathing and fastened to the framing is the most common and covers the majority of the surface area on each house.

On the inside, the plaster or gypsum board was removed and the interior surface of the sheathing sprayed with 2.0 pcf ccSPF insulation (in the framing cavity) to a depth of approximately 3 in.. The ccSPF forms the primary air barrier system. Penetrations through top and bottom plates for services are sealed to compartmentalize the framing cavities. Vapor control is provided by the ccSPF, which in this configuration effectively controls vapor diffusion and surface temperature of the (interior) condensing surface to limit the risk of wintertime interstitial condensation. This assembly is considered to be a vapor open assembly, in that the enclosure layers can dry from the ccSPF to the interior and from the ccSPF exterior.

In future retrofits in the program, if the interior finish cannot be removed, then the cavity will be filled with low density foam or cellulose insulation. If cavity insulation is already present (possibly installed during a prior retrofit) then insulation will occur from the outside as has been done with Cedar 1 and 2. If vermiculite insulation is discovered, proper remedial procedures will be used to remove the insulation and either the interior or exterior insulation approach will be possible.

4.1.1.3 Foundation

The foundations of the two NSP2 retrofit test houses include a concrete masonry unit (CMU) wall in Cedar 2, and a partial CMU foundation with a partial crawlspace in Cedar 1. In Cedar 1, where there is no evidence of water damage, the basement walls were insulated with 2 in. of full-height foil-faced polyisocyanurate insulation in the CMU section and approximately 2 in. of

ccSPF in the crawlspace section. In Cedar 2, where evidence of water damage exists, the following solutions were proposed:

- Repair water damage from the exterior and insulate as above for Cedar 1
- Break up floor slab and install interior drainage, insulate wall with SPF or drained board foam product
- Insulate with SPF.

However, during demolition work on the house, the foundation wall suffered a partial collapse (see Figure 5 below). Construction work was delayed and a final retrofit solution for the foundation was not determined at the time of this report.

Figure 5: Repair work on Cedar 2 foundation

Before the houses were examined, the team decided that, depending on the condition of the basement floor slab, the slab will either be replaced or left as is. Both houses had concrete floor slabs in serviceable condition so the slabs were not replaced and no insulation was added.
In future project houses, if the slab is to be insulated, the entire surface area of the basement will be insulated with 2 in. of XPS insulation. The sub-slab insulation is to be turned up at the slab edges as a thermal break and to maintain continuity with the foundation wall insulation.

4.1.1.4 Windows

New windows are vinyl frames with low emissivity spectrally-selective glazing. A U-value of 0.32 and a SHGC of 0.32 was chosen for cost reasons although individual builders should be able to improve this specification for future homes in the program. This glazing technology has some secondary benefits as well, such as reducing UV damage on interior floors or fading on furniture. As mentioned, the flanged window units are integrated with the exterior face of the insulating sheathing with flashing tape. All window openings are first lined with pan flashing.

After insulation, low expansion foam is used as an air seal between the window unit and the framing of the rough opening.

4.1.1.5 Infiltration

The air infiltration rate target is the BSC Building America infiltration goal of 2.5 in^2 of free area per 100 ft^2 of enclosure. The layer of spray foam applied to the interior side of the wall and roof sheathing is the primary air barrier system. The low expanding spray foam that is installed between the window frame and the rough opening is the transition from wall to window unit. In the basement, rim joist areas are sealed from the inside with ccSPF to connect the basement wall insulation to the underside of the first floor deck. The basement floor and concrete structure completes the whole house air barrier system.

4.1.2 Mechanical Specifications

Table 5 summarizes the mechanical systems used in the NSP2 project for both test houses.

Table 5. Wyandotte, Michigan NSP2 Mechanical System Specifications

	Mechanical Systems	Specifications
Heating	Description	9.2 HSPF ground source heat pump
	Manufacturer and model -	WaterFurnace
Cooling (Outdoor Unit)	Description -	18 SEER ground source heat pump
	Manufacturer and model -	WaterFurnace
Cooling (Indoor Unit)	Description -	ECM air handler with heat pump coil
	Manufacturer and model -	WaterFurnace
Domestic Hot Water	Description -	Tank electric hot water heater (EF=0.98), desuperheater
	Manufacturer and model -	Rheem
Distribution	Description -	R-6 flex ducts in conditioned unvented cathedralized attic
	Leakage	5% duct leakage to outside
Ventilation	Description -	Supply-only system with Aprilaire 8126 VCS, 33% Duty Cycle: 10 minutes on; 20 minutes off, 50 CFM average flow
	Manufacturer and model -	Aprilaire 8126 VCS fan cycler
Return Pathways	Description -	Central return on first floor, jump ducts in bedrooms

4.1.2.1 Heating and Cooling

Ground source heat pumps shift energy consumption from direct combustion to electricity—which in many cases may not be preferable from a site-source perspective—but have higher COPs than air source heat pumps, especially during periods of extreme temperatures when building loads are highest. Their application in single-family homes is limited due to the high cost of drilling. The horizontal heat exchangers common in residential construction also reduce performance.

As part of the project, the City of Wyandotte will drill vertical boreholes (see Figure 6) at each NSP2 project property in the City-owned portion of the front yard. These wells are estimated to support GSHP units totaling 6-8 tons. The expectation is that although each well will initially be connected to only one NSP2 house, in the long term, Wyandotte Municipal Services will connect two or three houses to each well and possibly join the wells together to create a district GSHP system. The utility will lease the heat exchanger back to the house occupants. In this way, the per-house cost of the system is reduced, and the cost is amortized over a longer period than most homebuyers or builders can accommodate. A more complete discussion of costs is provided in the following section. The energy efficiency of each NSP2 project is important because the load on the well will determine whether one or two additional houses can be added to the well. The City of Wyandotte has agreed to handle the long-term collection of energy use data for these homes and is interested in the possibility of engaging the National Renewable Energy Laboratory (NREL) to monitor the district GSHP system.

Figure 6. Photograph of a well operation for a GSHP system in the NSP2 neighborhood

4.1.2.2 Ventilation

The package specifies a central fan integrated ventilation system (CFIS) that has been extensively researched and tested by BSC [Rudd 2008, Hendron 2008]. This system draws outside air via a 6 in. flex duct to the return plenum of the HVAC system (see Figure 7). This allows the introduction of outside air to the living space whenever space conditioning is already operating. Fan cycling will turn on the fan at a 33% duty cycle (10 minutes on, 20 minutes off) in order to provide outside air during periods of no space conditioning. A 6 in. mechanical damper is also installed on the 6 in. outside air duct. This is controlled by the fan cycler and will close off the outside air duct during periods of consistent space conditioning to prevent over ventilation of the living space.

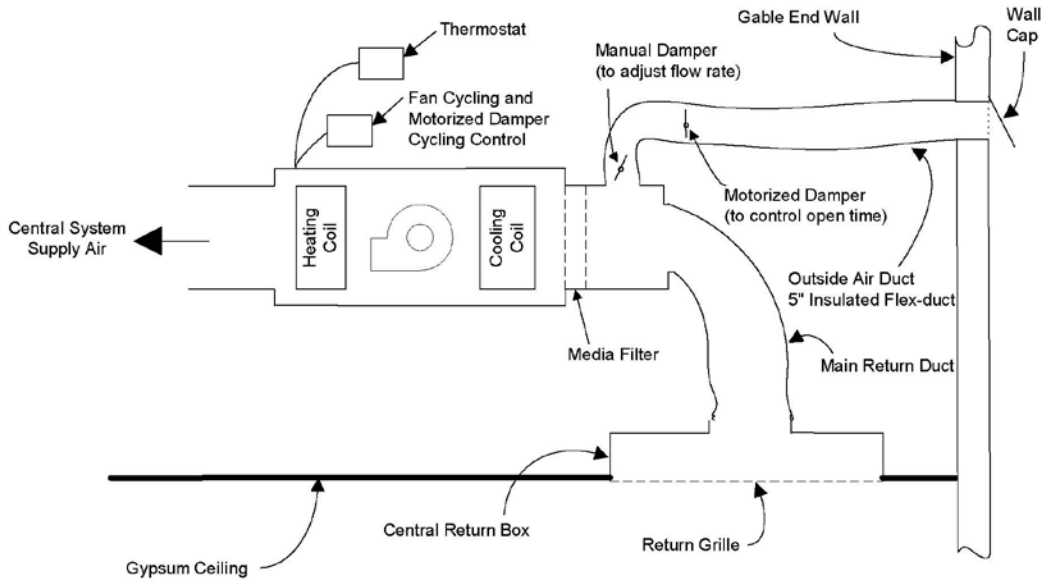

Figure 7. Central fan integrated supply ventilation schematic

In addition to the building enclosure and mechanical system specifications described, ENERGY STAR® appliances and compact fluorescent lighting are to be installed in all homes with the goal of further reducing internal loads and electricity use.

4.2 Energy Analysis Results—Cost Effectiveness of the Energy Efficiency Measures

4.2.1 Background and Cost Information

The Wyandotte NSP2 Retrofit energy efficient solution package has been designed by the project team to meet the cost and performance requirements of houses eligible for the HUD NSP2 program in the cold climate zone. Specifically, the Wyandotte NSP2 project, administered under MSHDA's NSP2 Consortium, aims to retrofit and build a significant number of houses that can be sold or rented to households earning less than 50% of the AMI. This is a different working definition of cost effectiveness than is typically used for Building America projects. The result will be that robust solutions developed for the NSP2 program in Wyandotte will be appropriate for both affordable and market-rate existing housing.

BSC participated in the project architect's work to value engineer the plans and specifications to meet the affordability objective—a package that can be built for less than $100 per square foot and make a significant improvement in the energy performance of the building. The $100/ft^2 cost was established as the program target by the City of Wyandotte based on the NSP2 funding and the expected sale price of the finished homes. BSC has conducted analysis of energy efficiency measures and other elements of the technology package to optimize the cost. This effort to reduce the cost while maintaining or increasing the energy performance of the houses will continue throughout each phase of the program..

It should be noted that the retrofit budget for the test houses is not just energy related: both of the houses were in very poor condition before the retrofit work (they were selected for this reason) and underwent complete interior renovations and also had significant upgrades to the enclosure and mechanical systems. It is expected that this investment has significantly extended the service life of these buildings.

Although the aim was to develop standardized approaches, it is likely that future retrofit homes in the program will present special challenges to the design team. The full NSP2 project aims to retrofit 20 houses, but BSC has planned for involvement with two houses.

Initial cost studies of the Wyandotte NSP2 package indicated that a significant retrofit (enclosure, mechanical system and interior finishes) could be implemented for between $95 and $105/ft^2 . The following table records reported incremental costs for only the energy efficiency and durability measures in the final technology package.

Table 6: Cost Information Summary Table

Category	Description	Cost	Source
Wall	Hybrid R-23	Default	
Windows	DG Vinyl (U=0.32, SHGC=0.32)	$6,500	Builder pricing (average)
	Window flashing	$400	Builder pricing
Roof	Unfinished attic	Default	
Foundation	Finished 8 in. ccSPF	Default	
	Full height R-10 rigid insulation	$2,400	Builder pricing
Infiltration	2.5 ACH50	Default	
Ventilation	CFIS	$365	Builder pricing
	Jump ducts, transfer grilles	$150	Builder pricing
Duct System	Ducted supply and panned return	$1,750	Builder pricing
	Fully ducted return	$900	Builder pricing
Duct Sealing	Conventional (Tape)	$175	Builder pricing
	Recommended (Mastic)	$275	Builder pricing
Heating and Cooling	GSHP 18 SEER, 3.7 COP	$11,800	BSC cost data sheet (for 3 ton; less $800 for DHW)
	Well for GSHP	$10,000	Builder pricing

Category	Description	Cost	Source
Hot Water	Electric tank with desuperheater connection to GSHP	$800	Builder pricing
Lighting	100% CFL	0.98	BSC cost data sheet (per sf FFA)
Appliances	ENERGY STAR washer, fridge	$800	BSC cost data sheet (imputed, 2/5 of $2000 for 5 appliances)

4.2.2 BEopt Modeling Results

The cost effectiveness of the retrofit energy efficiency measures considered for these projects was analyzed with BEopt, the Building America performance analysis tool. This tool includes an optimization capability that uses user-supplied cost data and energy use information for a specified set of energy saving measures to determine combinations of measures that are optimal or near optimal in terms of cost effectiveness. BEopt plots the average source energy savings per year against the annualized energy related costs. In this output, the optimal packages are those that form the lower bound of the plotted data points. BEopt uses a sequential searching technique so that not every possible combination of options is simulated.

BEopt modeling indicates that each proposed building upgrade reduces energy demand and total energy-related dollar cost. This modeling is intended to represent a generic house of the set that will be retrofit in Wyandotte. For this analysis, characteristics that were typical of houses in the NSP2 area were used. These characteristics are summarized in Table 2 under the “Existing Building” column.

Of course, every existing home is unique. This initial parametric study for what was considered to be a typical home (see Figure 8 below) predicted a savings of 55% of the estimated whole house annual energy use compared to the estimated current, pre-retrofit rate of consumption. This study was used to help assess cost saving measures early in the design process.

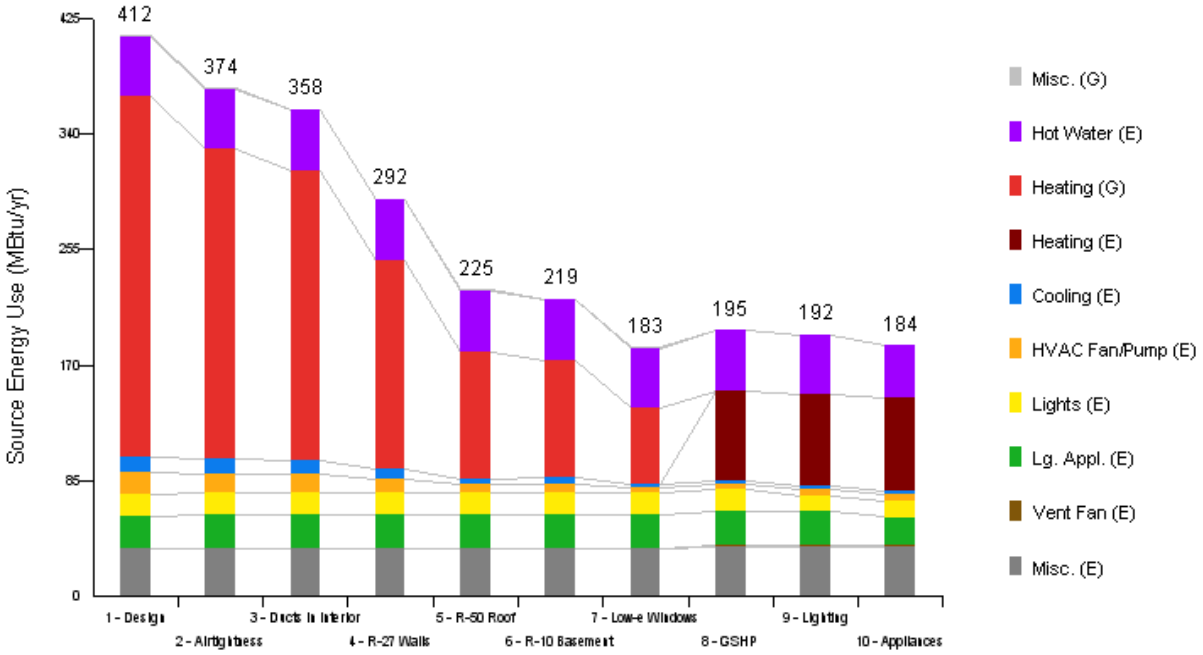

Figure 8. Preliminary BEopt parametric study for Wyandotte NSP2 retrofit test home

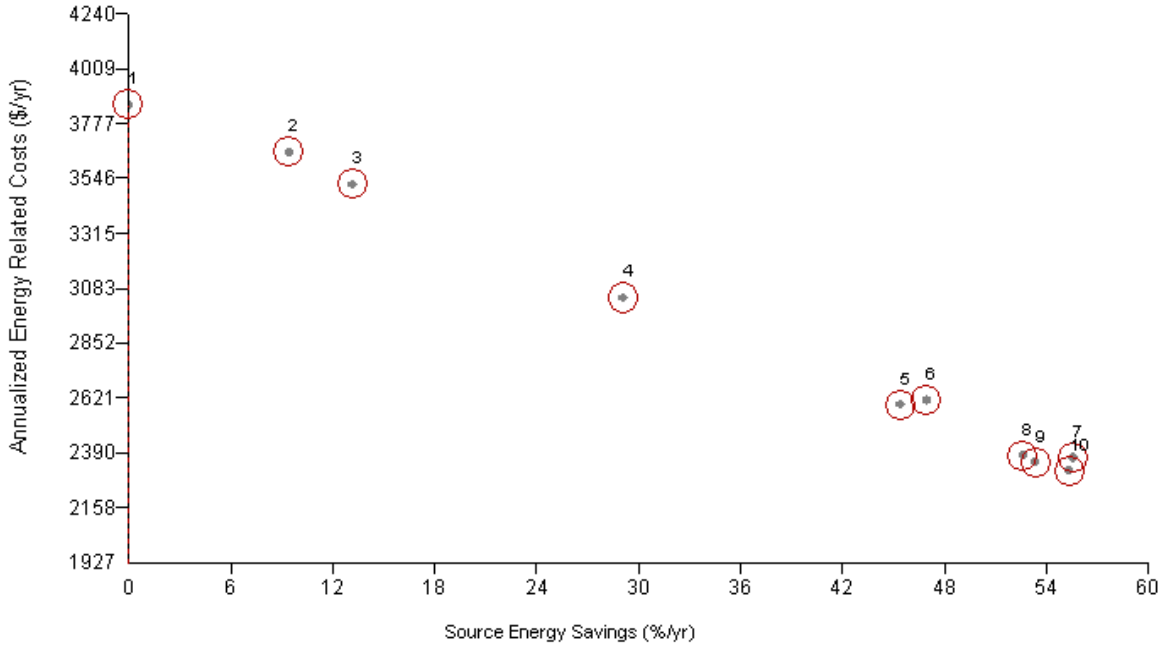

Figure 9. Preliminary BEopt cost study for Wyandotte NSP2 retrofit test home

In particular, the base home modeled in this report has uninsulated walls, typical of construction at the time these houses were built. It is expected that some of the homes in Wyandotte have

been retrofit with blown insulation since construction. Since there is more opportunity to save energy in buildings that have not been improved since construction, BSC and the City of Wyandotte have preferentially selected those which are most in need of improvement for this research project.

The analysis was repeated towards the end of the design process for the final technology specification after several refinements had been made (see Figure 10). The results indicated an estimated 42% reduction in annual whole house energy use compared to the Building America Benchmark.

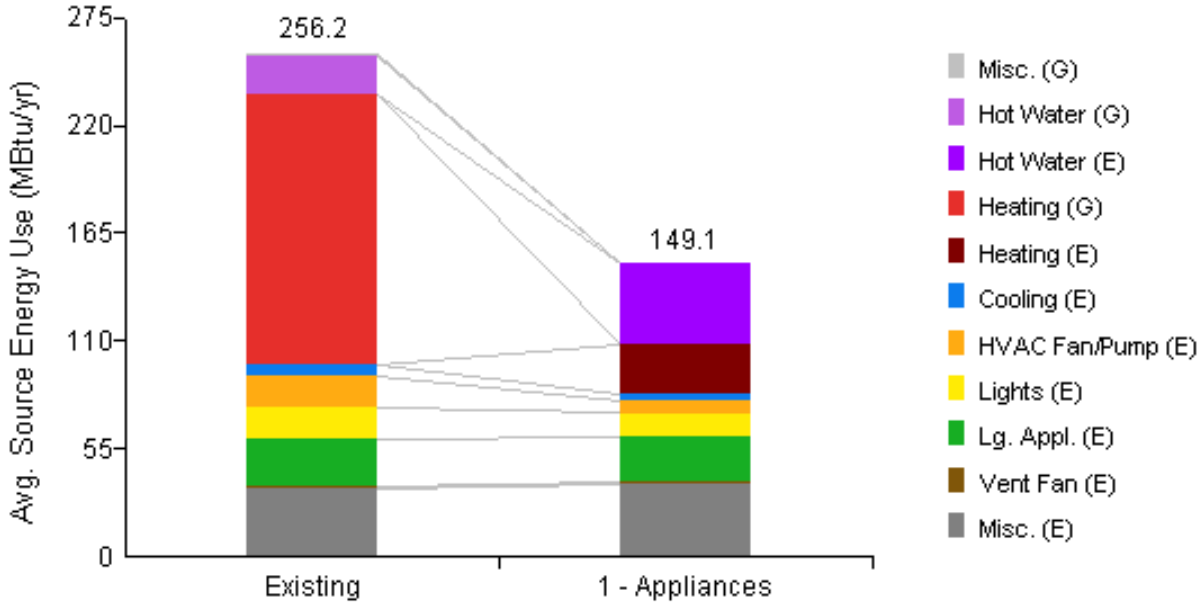

Figure 10. Final BEopt energy analysis results by end use

Figure 11 below provides an updated cost study using the final specification for the test homes. Note that the GSHP system, but not the cost of the bore-hole, is included in this analysis.

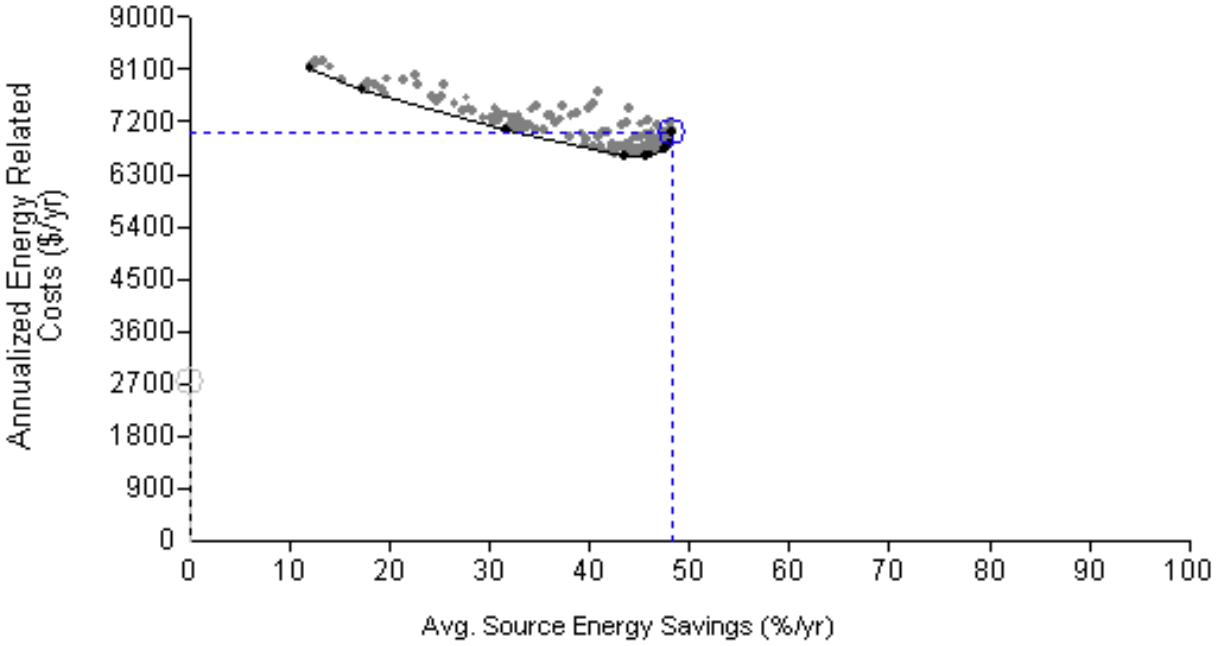

Figure 11. Final BEopt cost study

4.3 Airtightness Testing Results

The following table summarizes the performance testing results for the houses completed. Test reports are included in Appendix D.

Table 7. Wyandotte NSP2 Enclosure Performance Testing

Address	House Type	Blower Door Results
Cedar 1	Two-story, 1575 ft^2, single-family detached. Volume: 18792 ft^3	A pre-retrofit blower door test was not possible for Cedar 1 because significant work had already started. We estimate that the result would have been in the 20-25 ACH50 range based on our past experience with this type of construction. A post-retrofit blower door test was completed on June 27. The results of this blower door test showed a leakage rate of 2135 CFM at 50Pa. This correlates to an approximate 5.2 ACH at 50Pa. Areas of significant leakage include the first floor to second floor rim joist, cracks in the uninsulated basement, missing details on the crawlspace spray foam application, unsealed details where the spray foam meets the floor polyethylene, and penetrations installed post spray foaming. These areas were discussed with Ralph Hope on site. Air sealing and insulating of the uninsulated basement was recommended. To detect and repair air leakage areas, it is recommended that a blower door test be completed prior to drywalling the interior of each house. This will facilitate detection AND subsequent repair of leakage areas. A post repair blower door test was completed. The results of this blower door test showed a leakage rate of 1833 CFM at 50Pa. This correlates to an approximate 4.5 ACH at 50Pa and 0.39CFM/ft^2. Although this shows an improvement, some of the recommended repairs were not completed. The missing spray foam at certain areas of the rim-sill plate intersection in the crawlspace remain, as well as unsealed details where the spray foam meets the floor polyethylene. Corrective action will continue.
Cedar 2	1.5 story, 1327 ft^2, single-family detached. Volume: ~5500 ft^3.	The initial pre-retrofit blower door test was completed on June 27. The results of this blower door test showed a leakage rate of 4269 CFM at 50Pa. This correlates to an approximate 21 ACH at 50Pa. Areas of significant leakage include the attic floor, the basement rim joist, existing windows, kneewall attic access hatches, and unsealed abandoned chimney. A final airtightness test was completed. The results showed a leakage rate of 755 CFM at 50 Pa – a significant improvement over the existing conditions. This correlates to an approximate 3.2 ACH at 50Pa and 0.52 CFM50/ft^2.

5 Discussion

5.1 General

In the NSP2 retrofit project in Wyandotte there are some challenges (which are discussed below) that need to be overcome to reach targets on energy efficiency and cost; however, given the commitment of the City of Wyandotte and the responsiveness of the builders, these targets seem within reach.

5.2 Documentation

The project has a special bid process and other MSHDA requirements that would not be found in typical projects and these contribute to the level of detail in the drawings. While not typical, this documentation set is an excellent example of the level of detail that is needed for the construction of a high performance home incorporating new construction techniques.

A drawing-related issue that is common to both the new and retrofit construction in the NSP2 project is the separation of architectural and mechanical information. This stems from a unique situation on the Wyandotte project: the mechanical design and installation was bid as a separate package. Since the separation also extends to the construction site (the builder of the house does not hold the contract for the mechanical system installation) the layout of the mechanical system has been negotiated on the construction site. In a more conventional situation, BSC would recommend an integration drawing like the example in Figure 12 below.

If the Wyandotte project was expected to involve further drawing work, we would expect that additional refinement of the drawing sets would be possible.

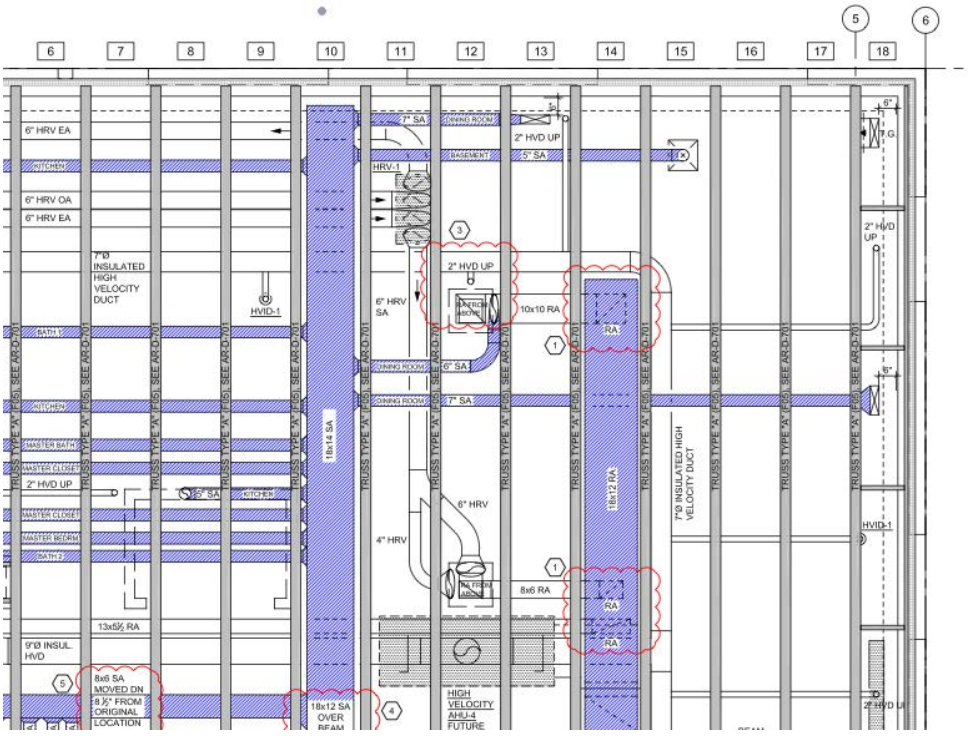

Figure 12. Example of floor framing plan with mechanical layout

5.3 Builder Selection and Training

BSC staff conducted workshops on June 18 and October 6 for the builders involved in the project; see Appendix D: Site Visit Reports for the presentation material and attendance list for these workshops.. A typical workshop included three parts: an introduction to Building America and high performance housing, a presentation on Advanced Framing (which was targeted at new construction), and an on-site discussion of framing details. In one of the workshops, BSC demonstrated blower door testing and this information has become useful to builders in the retrofit program. The team expects that additional work on-site to inspect and explain air tightness details in retrofit homes will be needed given the great range of construction types involved in the retrofit program. Based on the room for improvement in the airtightness measurements, BSC recommends that a future workshop specifically addressing this issue for retrofit construction be provided by the project team.

5.4 Foundations

The foundation existing pre-retrofit at Cedar 1 was a combination of an uninsulated basement accessed from the exterior at the rear of the house, and an un-insulated, vented crawlspace at the front of the house. The strategy for the crawlspace was to seal, insulate, and condition this area as a conditioned crawlspace. A polyethylene sheet was placed on top of the ground and overlapped by the spray foam as a complete air barrier.

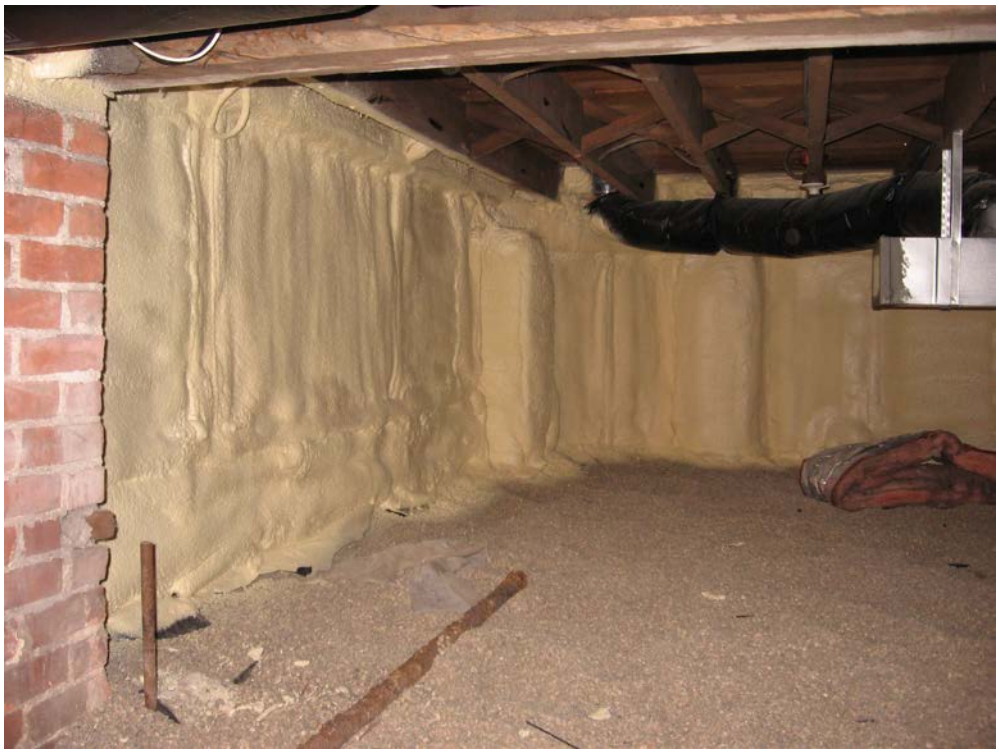

Figure 13. Spray foam installation in conditioned crawlspace at Cedar 1

The basement to the rear of the house was converted to a mechanical room. The foundation walls were not insulated at last inspection but insulation and air sealing of the rim joist areas with

spray foam was completed. BSC has recommended that insulation of the basement walls be completed prior to final testing of the house.

5.5 Insulation and Air Sealing

The hybrid insulation retrofit strategy chosen for this project has provided a significant improvement in thermal performance and air flow control; however, there are several areas where the process could be improved. These are discussed in Table 8 below.

Table 8. Common Points of Air Leakage

 (photo courtesy of Steven Christensen, WARM Training)	**#1 – Rim joists.** The primary issue with this location is that there may not be enough room for the installer to position the spray foam applicator so that insulation is sprayed on surfaces behind and around all sides of the rim joist. After the foam expands, this area may or may not be adequately air sealed.
 (photo courtesy of Steven Christensen, WARM Training)	**#2 – Penetrations.** The photograph to the left shows a hose bib that has been installed after the foam has been cut away. This is a common problem where workers do not repair the air seal after the penetration for the SPF installation has been made.
	**#3 – Attic Rafter to Floor.** Although coverage of the underside of the roof with spray foam looks to be complete, it is common for leakage paths to be missed at the intersection of the attic rafters and the attic floor.

5.6 HVAC Installation

The HVAC equipment—a GSHP, hot water tank, and air handler—were installed and commissioned by the installer in Cedar 1 but not Cedar 2 at the time of this report. As specified, all ductwork joints and seals have been sealed with mastic (see Figure 14 below). Pressure testing of the ductwork system has not been completed. All ductwork has been installed inside the thermal enclosure as specified.

Figure 14. Typical ductwork sealing at takeoff from trunk; elbow to the site is sealed

5.7 Lighting and Appliances

A 100% CFL package and ENERGY STAR appliances have been specified for the NSP2 houses and these will be included in the final sale.

5.8 Sales and Marketing

The NSP2 retrofit homes will be sold by the City of Wyandotte through a real estate agent who has been contracted to sell all of the NSP2 new and retrofit homes. The project has received some attention in the local media and it is expected that as more new and retrofit homes are ready for market, this exposure will increase. At present, there is no direct marketing of the energy efficiency features of the homes beyond some basic notes in the real estate listing. BSC has recommended a home buyer education session (see Section 5.10: Homebuyer Education below) and will provide information published by Building America to the City of Wyandotte and the real estate agent.

5.9 Purchase Price

The list price for Cedar 1 is $100,000 but has been put on the market with special restrictions on income class and a special long-term agreement on the ownership of the property. It should be noted that under a direct purchase of the house, the list price would be higher—more in line with the construction costs.

MSHDA's NSP2 Consortium aims to retrofit and build a significant number of houses that can be sold or rented to households earning less than 50% of the AMI. The following example explains how the NSP2 houses will be priced and sold.

If a family of seven has a total household income of $42,000 per year, they are considered low-income and are eligible to purchase an NSP2 home. They have completed 8 hours of home counseling and qualified for a mortgage because they also have good credit and reliable income.

The next step is for the housing counselor to determine the price per month the family can afford to spend on housing payments. Again, the home buyer's PITI cannot exceed 30% of the household monthly income. For this particular low-income family, that means that PITI cannot exceed $1,050 per month. Working backwards with estimated taxes and insurance at $291.66 and $66.66 per month respectively, the housing counselor says that $691.68 is the most this family can allocate for principal and interest on a mortgage. On a 30-year mortgage at 5%, they can afford to purchase the home for $120,000 because the monthly principal and interest payment will be $644.19. Monthly PITI will come to $1,002.52, which is under their limit of $1,050.

The particular home this family is purchasing cost $180,000 to build and appraised for $125,000. The listing price was the lower of the two, as per NSP2 requirements. The family can afford to purchase for $120,000, which will give the family $5,000 in homebuyer assistance and a total NSP2 subsidy of $60,000. The family will have a 5-year no-interest lien on the home in the amount of $5,000 which will dissolve 1/5 or 20% ($1,000) per year over the five years that they live in the home. If the family should move out or sell prior to this, a percentage of the lien is due to MSHDA at the time of closing.[4]

As explained above, Table 9 shows that the total projects costs for each house were significantly above the list price, and this is expected for an NSP2 community.

Table 9. Construction Cost and List Price for Wyandotte NSP2 Retrofit Homes

House Number	Construction Cost	List Price	Description
Cedar 1	$188,000	$100,000	1453 ft2, 3 Bed, 2 Bath
Cedar 2	$139,000	$90,000 (est.)	1327 ft2, 3 Bed, 2 Bath

5.10 Home Buyer Education

A homeowner manual based on previous work by BSC has been developed for this project and will be given to purchasers. BSC typically recommends that an introductory presentation on the operation of a high performance house be provided and in this case a public presentation for homebuyers and prospective homebuyers would seem like a good fit with the program goals.

[4] More information about the NSP2 program can be found here: http://www.wyandotte.net/Departments/Engineering/HousingRehabilitationProgram.asp

6 Conclusions

6.1 Discussion of Research Questions

The retrofit test homes discussed in this report serve as examples of high performance retrofit enclosures that could be built in a cold climate area similar to Detroit, Michigan.

Both test houses in this study had significant construction issues that required additional work to reduce the impact on the final performance. However, improvements in whole house energy use are within the target range (estimated to be 42% savings over the pre-retrofit conditions based on the as-built post-retrofit specification) and the enclosure retrofit will significantly extend the service life of these houses.

Answers can be given to the project research questions:

1. *Does the ccSPF retrofit insulation strategy provide the planned level of airtightness in the existing building frame?*

The answer is: yes; however, there is room for improvement and more consistency is needed. The construction process and detailing of the assembly can both be adjusted. The post-retrofit blower door testing conducted on Cedar 1 indicates that, as a "first attempt" by the builder, the BSC Building America air tightness target of 2.5 $in.^2$ leakage area per 100 ft^2 enclosure @ 50 Pa is achievable using the retrofit wall assembly, if common areas of air leakage are addressed.

BSC staff observed that a significant amount of air leakage occurs in several areas. Because of these findings, the project manager decided to change the QC process moving forward to include a pre-drywall blower door test for each home to help identify deficiencies earlier in the construction process.

2. *Where insulating sheathing is used with replacement windows, can water management details for insulating sheathing be cost-effectively executed by the construction team?*

The answer is: yes. Work on site to-date has indicated that the details can be executed with reasonable speed and effectiveness given some initial training for the installers. BSC's inspection of the construction for both houses showed that the work was on par with new construction using a similar wall assembly.

3. *Does the total project cost fall within the project requirements and deliver higher than expected energy performance?*

On the energy performance side, BEopt modeling with as-built post-retrofit specifications shows that 42% whole house energy savings is likely achievable. Data from the occupied houses is needed to confirm this and the City of Wyandotte will be collecting utility bill data after the houses are sold.

On the cost side, Table 9 shows that Cedar 1 was retrofit for \$129.50/ft^2 and Cedar 2 was retrofit for \$105.10/ft^2. Both houses are above the \$100/ft^2 target set for the program.

4. *Is the sizing method for the GSHP accurate for small houses with high thermal resistance enclosures?*

Data from completed and occupied houses is not currently available. However, equipment sizing calculations have shown that the enclosure improvements should result in a decrease in the capacity that was expected. More information is needed to make a final determination. This question will need to be answered by future research work.

5. Can the GSHP unit be reduced in size to accommodate additional homes on the same well? The progress that has been made on the houses constructed by the program to date demonstrates that this is a real possibility. Based on the load calculations using the relatively high levels of insulation, above average windows, and the BSC Building America air tightness specification, it would seem possible to accommodate two small houses on a typical 6 to 8 ton well. However, the final as-built airtightness of the enclosure and the performance of the wells that have been installed are major variables in this estimation. With some work, efforts to reduce the building heating and cooling loads can be increased. Measuring performance of the wells should be undertaken by Wyandotte Municipal Services. In the future, Wyandotte Municipal Services intends to examine the possibility of linking wells together to form a district system. Low-load houses will be an asset if a district system is developed.

6.2 Future Development for Higher Performance Levels

Retrofit work is unlike new construction in that even seemingly identical houses built to the same plans, by the same builder, at the same time, may have very different pre-retrofit conditions due to renovation work, homeowner habits, and lifestyle, poor maintenance, and accidental events such as flooding and fires. Assessing pre-retrofit conditions, therefore, is an ongoing concern in addition to specific challenges for any construction that must be overcome to reach the estimated energy savings. These include:

- Achieving a coordinated approach between the architectural plans and the mechanical system design and installation.
- Supporting multiple builders as they adjust to new construction techniques and new materials.
- Implementing a quality control process based on performance testing and feedback for the builder, specifically in the areas of air sealing and cladding attachment.
- Adjustment of plans and specifications to incorporate solutions for issues observed on site, specifically involving framing and water management details.
- Developing a plan for marketing to buyers and educating homeowners.

There are many issues that may change the specifications in these homes going forward. They include: cost and budget concerns, requirements of other rating and certification programs, material availability, and labor experience. BSC will continue to work with the City of Wyandotte to make necessary changes to the improvements while maintaining the high standard of construction that is required by the Building America program.

6.3 Gaps in Existing Measure Guidelines

The following gaps were identified in existing measure guidelines:

6.3.1 Quality Management Strategies

Wyandotte NSP2 is not a typical project in the way that the funding and project management is structured. However, as codes and standards change, it may become more common for local building departments, state housing authorities or utility programs to be in a position to specify a high performance housing product. A quality management process is essential to achieving the estimated energy performance of many of the construction strategies used at Wyandotte.. Experience with the Wyandotte project suggests that this measure guideline should also be targeted to local building departments, state housing authorities and utility providers.

6.3.2 Recommendations for Future Measure Guidelines

Based on the retrofit work completed at Wyandotte, the following measure guidelines would address key problems with performance or general knowledge:

6.3.3 Ground Source Heat Pumps for Cold Climate Homes

This technology is a popular choice for many builders in cold climate locations. Information about the proper sizing and operation of these units is not available from Building America in the form of a measure guideline. Additional research that includes longer term monitoring of installed systems in a number of situations could be an important part of such a publication.

6.3.4 Heat Recovery Ventilator and Energy Recovery Ventilator Systems for Cold Climates

These systems are not being used in the Wyandotte NSP2 houses, but this technology was considered during the energy analysis phase and several builders in the program have asked about the use of these systems. Clear guidance from Building America—particularly regarding the effectiveness of both HRVs and ERVs in cold climates—is needed.

7 Acknowledgments

The City of Wyandotte's community development program is part of a Michigan State Housing Development Authority-led consortium that is funded by HUD under the NSP2 program. The City of Wyandotte has also been awarded DOE EE&CBG funds that are being used to develop a district GSHP system to service the project. Wyandotte's success is in large part due to the vision and motivation of the City's Municipal Services Department and the efforts of the project architect and other contributors.

Building Science Corporation's involvement on this project is funded by the Department of Energy's Building America Research program. BASF Corporation, a member of the Building Science Consortium, has supported Building America's involvement in the project through the hard work of their research staff and through the use of their local facilities.

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Appendices

Appendix A: MSHDA Wyandotte, Michigan NSP2 Target Areas
Appendix B: Wyandotte, Michigan NSP2 Initial Energy Analysis (November 9, 2010)
Appendix C: House Plans for Wyandotte NSP2 Community
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Appendix E: Press Reports
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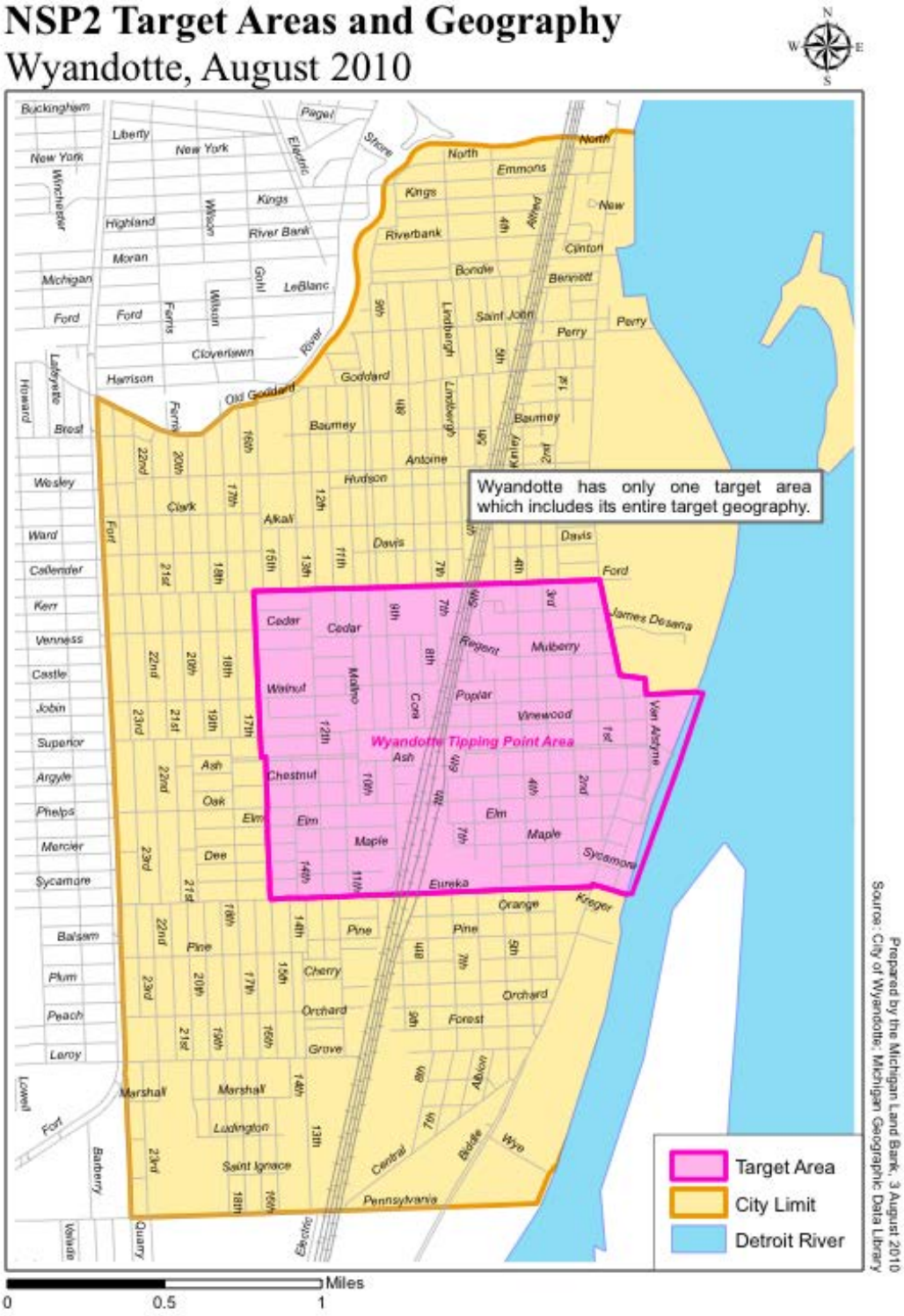
Appendix A: MSHDA Wyandotte, Michigan NSP2 Target Areas



Appendix B: Wyandotte, Michigan NSP2 Initial Energy Analysis (November 9, 2010)

TECHNICAL SUPPORT FOR ENERGY EFFICIENT, AFFORDABLE NSP2 HOUSING IN WYANDOTTE, MI – PRELIMINARY REPORT

Alex Lukachko and Philip Kerrigan, Building Science Corporation
November 9, 2010

Introduction

In 2010, Building Science Corporation, through the Building America research program, assisted the City of Wyandotte with the first phase of a mixed new and retrofit affordable housing Neighborhood Stabilization Project 2 (NSP2) project in Michigan. Initial work included refinement of plans and specifications that were included in the preliminary bid package. The project, which is expected to extend into 2012, will include approximately 25 new houses and 19 retrofits of existing homes in the downtown area.

Project Information Summary Sheet

PROJECT SUMMARY	
Company	City of Wyandotte
Company Profile	Incorporated in 1867, the City of Wyandotte is often described as the 'Heart of Downriver.' The site where Wyandotte sits today was, in the 1700s, a village for the Native American tribe known as the Wyandot, a part of the Huron Nation. A waterfront community, Wyandotte is rich in history and is known for its distinctive architecture, charming downtown district and variety of cultural offerings. The City has been awarded the designation of a Preserve America Community by the Federal Government. Wyandotte Municipal Service Commission provides electricity, water, and telecommunication utilities for Wyandotte. This City owned utility was created in 1889. More information about the City of Wyandotte can be found at www.wyandotte.net
Contact Information	Mark A. Kowalewski, P.E., City Engineer City of Wyandotte 3131 Biddle Ave. Wyandotte, MI 48192 Tel: (734) 324-4500
Division Name	n/a
Company Type	City - NSP2 recipient
Community Name	Wyandotte NSP2
City, State	Wyandotte, MI
Climate Region	Cold, Climate Zone 5

SPECIFICATIONS	
Number of Houses	25 new, 19 retrofit
Municipal Address(es)	varies
House Style(s)	Various single family homes
Number of Stories	1.5 stories typical
Number of Bedrooms	3 typical
Plan Number(s)	247 Walnut

Floor Area	1475 ft^2
Basement Area	~600 ft^2
Estimated Energy Reduction	Greater than 40% under BA Benchmark
Estimated Energy Savings	More than $780 per year
Estimated Cost	Target construction cost is $100 per ft^2
Construction Start	Expected late 2010
Expected Buildout	End of 2012

Preliminary Technical Support

In August, BSC worked with industry partner BASF and the City of Wyandotte to develop a technical specification for the new and existing houses in the planned project. The project architect working for the City prepared plans for the first three houses to be tendered. BSC provided initial advice on enclosure and mechanical systems, and planned to complete an energy analysis when the house plans were moved to a more developed stage. A major issue for the design team was the planned budget for each house. The architects worked with an estimator to establish baseline costing for proposed enclosure and mechanical system specifications. BASF worked with the City on material supply and pricing in an effort to provide more certainty on the material pricing.

On September 22 and 23, 2010, BSC staff met with the City of Wyandotte and BASF. With the City, BSC discussed the systems engineering approach that will be employed on the new and retrofit plans being developed by the architect. BSC also presented the results of a preliminary energy analysis (see section below) based on as-is plans and specifications. BSC discussed deployment strategies for the planned high performance houses, which will include some element of information/education for trades bidding on the work for this project. This will be designed to broaden the understanding of high performance housing techniques in the local workforce. Plans for collecting utility bills from the completed houses were discussed and will be implemented by the City.

Following the meeting with the City, BSC and BASF met with the project architect and HERS provider. A brief review of the tender packages for the first three houses was conducted. Testing and inspection requirements were discussed with the HERS rater.

On September 23, BSC and BASF met with the architect to review the plans in more detail. Technical specifications and details for air tightness, water management and thermal control were discussed. BSC and the architect then met with the engineering firm that will provide the district GSHP system for the city to discuss basic details of the system. BSC noted that significant technical support and monitoring may be required for this system, possibly a research interest for NREL researchers. More information on equipment sizing, DHW, ventilation, and ducting will be collected from the HVAC installer hired for this project at a future meeting.

A visit to several of the proposed project sites was made at the end of the day. BSC observed that the sites are well distributed in a lively neighborhood and will be excellent examples of neighborhood development.

Preliminary Whole-House Performance and Systems Engineering

The following is a preliminary energy analysis of one of the new house plans developed for the project. The reader should note that at the time of this analysis, not all energy efficient upgrades to the original specifications were agreed upon and implemented. While the preliminary analysis shows a significant energy savings, the project team expects that additional savings will be realized as the project develops.

The 247 Walnut floor plan is a two story detached house with a full conditioned basement. Table 10 below lists some of the basic dimensions and areas that were calculated through a plan takeoff. Some dimensions (such as floor area) may be different than what is listed in the drawing set due to takeoff procedures.

Table 10: Basic dimensions and areas for 247 Walnut

Floor area (sf)	Surface Area (sf)	Volume (cf)	Beds (ct)	Baths (ct)	Glazing Ratio
1475	4077	24969	3	2.0	24.8%

Whole house hourly energy consumption simulations were completed calculating the source energy consumption savings for 247 Walnut compared to the 2010 Building America Benchmark Definition created by DOE. The Building America Benchmark is a protocol for creating a reference house to which the target floor plan (247 Walnut, in this case) is compared to in order to calculate a percentage savings. The BA Benchmark specifies a home with similar dimensions vs. the target floor plan but with standard code specifications that are based on the 2003 IECC. Other assumptions are built into the definition (lighting, appliances etc.) so a complete model of the entire house can be created. This provides an energy “baseline” that allows a percent savings to be calculated for Building America homes using computerized models (Energy Gauge USA).

Whole house hourly energy consumption simulations were also completed vs. the 2009 IECC. Table 11 summarizes the characteristics for each of the three categories. In some cases, BSC had to make some assumptions; those are noted in the table.

Table 11. Building Energy Specifications

	Current Builder Specifications	2010 BA Benchmark	2009 IECC
Building Enclosure			
Roof	Unvented cathedralized attic R-49 total: 2" SPRAYTITE® (R-10.48) + 10" R-38	Assembly U-value 0.026 (~R-38 equivalent)	R-38 unvented cathedralized attic
Walls	R-33 total: 2x6 @ 24" o.c. framing with 2" SPRAYTITE® (R-10.48) and R-13 batts 2" NEOPOR® R-9.2 as insulating sheathing	Assembly U-value 0.058 (~R-17 equivalent)	R-13 cavity insulation with R-5 insulating sheathing
Basement Walls	2" foil faced polyisocyanurate full length	Assembly U-value 0.096 (~R-10.5 equivalent)	R-10 continuous rigid insulation
Windows	vinyl double glazed assumed (U=0.32, SHGC=0.32) glass block windows (U=0.6, SHGC=0.6)	U=0.39, SHGC=0.32 glass block windows (U=0.6, SHGC=0.6)	U=0.32, SHGC=0.40 glass block windows (U=0.6, SHGC=0.6)
Infiltration	1944 CFM 50 (3.55 Ach 50) assumed	2786 CFM 50 (5.08 ACH 50)	3239 CFM 50 (ACH 50)
Mechanical Systems			
Heat	3.3 COP (assumed) ground source heat pump	6.8 HSPF air source heat pump	7.7 HSPF air source heat pump
Cooling	14.1 EER (assumed) ground source heat pump	10 SEER air source heat pump	13 SEER air source heat pump
DHW	0.90 EF electric tank water heater assumed	0.86 EF electric tank water heater	0.86 EF electric tank water heater
Ducts	R-8 flex runouts in conditioned space 15% total duct leakage assumed	R-3.3 ductwork in conditioned space 15% total duct leakage	R-6 ductwork in conditioned space 15% total duct leakage
Ventilation	45 CFM continuous ventilation with ASHRAE 62.2 rated exhaust fan)	45 CFM continuous ventilation with ASHRAE 62.2 rated exhaust fan)	45 CFM continuous ventilation with ASHRAE 62.2 rated exhaust fan)
Appliances and Lighting			
Lighting	86% Incandescent / 14% Compact Fluorescent	86% Incandescent / 14% Compact Fluorescent	86% Incandescent / 14% Compact Fluorescent
Appliances	Standard Appliances assumed	Standard Appliances	Standard Appliances

Table 12 below outlines the calculated energy savings for 247 Walnut for both comparisons. The house saves 39.1% vs. the Benchmark. The predicted HERS Index is also listed for each configuration. The floor plan with the current specifications receives a HERS Index of 75, compared to the 70 or lower that is needed to be Builder's Challenge certified.

Table 12. Simulation Results for 247 Walnut

Description of change	% savings	Annual energy cost	Savings	HERS Index
2010 BA Benchmark	n/a	$2,342	n/a	111.0
Current Builder Specifications	39.1%	$1,560	$782	75.0
2009 IECC	n/a	$2,251	n/a	102.0
Current Builder Specifications	30.7%	$1,560	$692	75.0

The total annual energy costs were predicted using local utility rates:
Wyandotte Municipal Services *~$0.09/kWh Residential Rate*

Figure 17 is a bar graph that shows the whole house source energy use broken down into components. Energy consumption for heating was reduced the most. This is due to the enclosure upgrades along with the ground source heat pump.

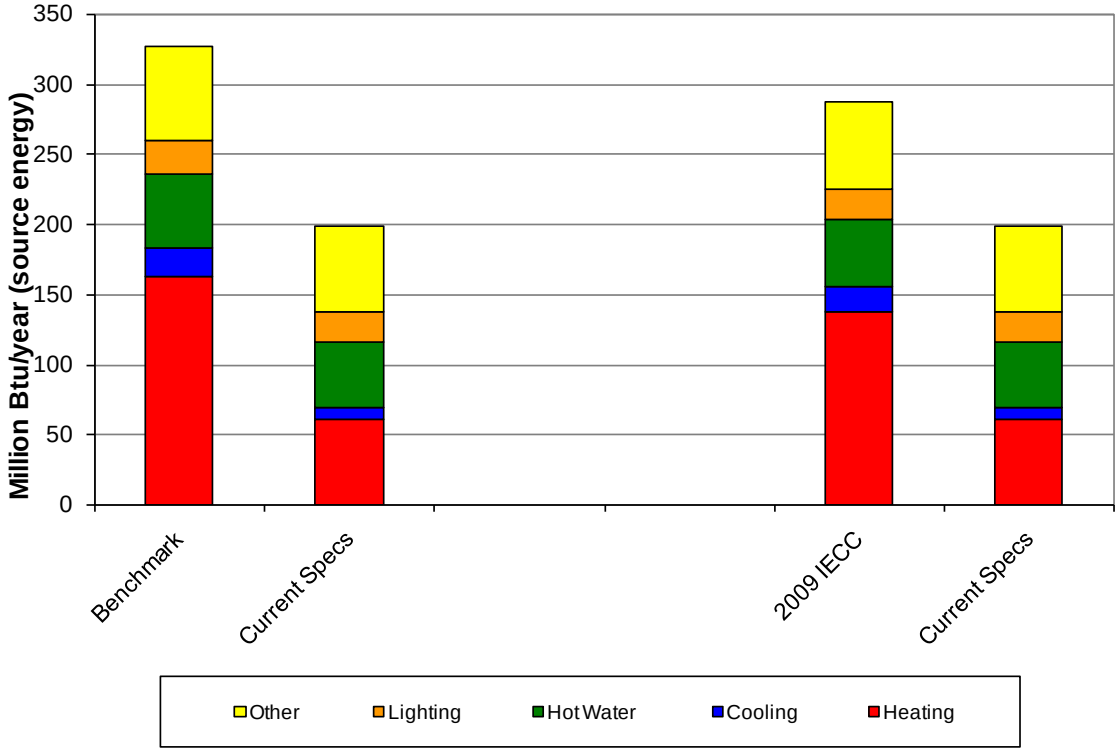


Figure 15. 247 Walnut parametric results graph

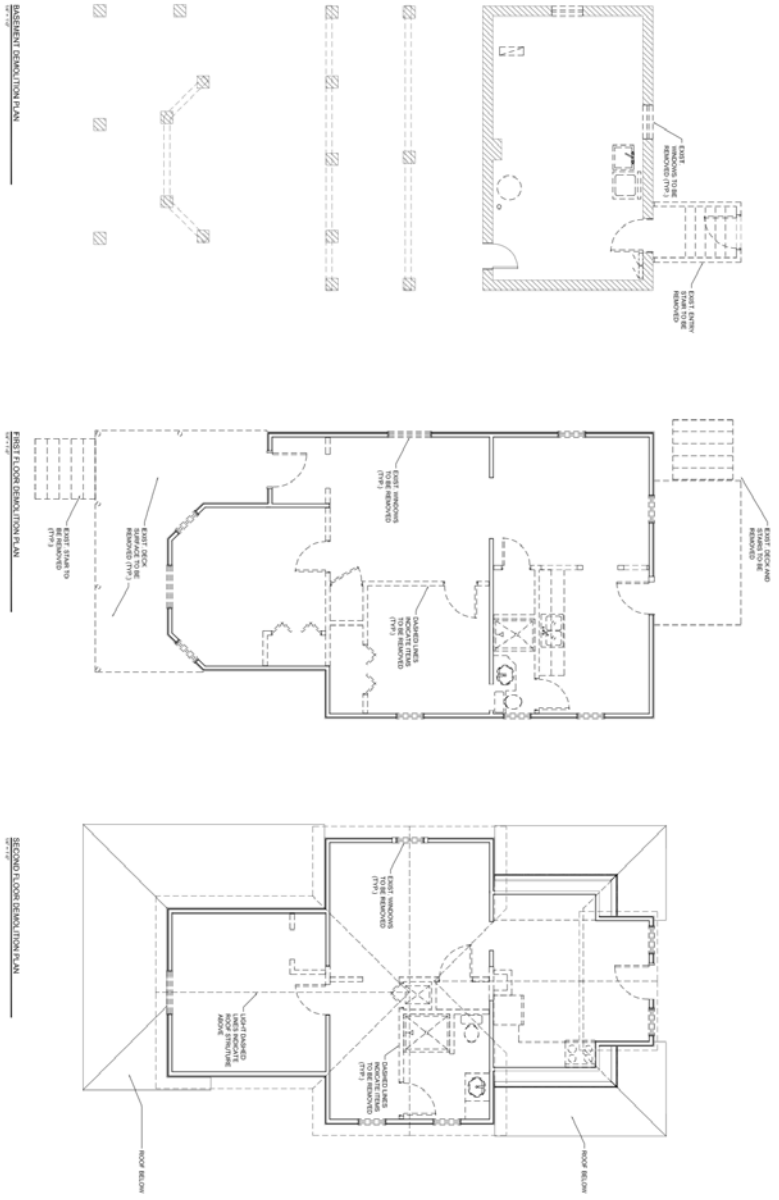
Preliminary Conclusions

The NSP2 project of the City of Wyandotte has good potential to achieve affordable high energy savings for new and existing homes. The preliminary plans developed by the project architect show excellent attention to building science detail, and a significant amount of work has been done to integrate energy efficiency and durability measure into the buildings while maintaining the aggressive construction cost target set by the City. BSC anticipates that additional energy savings will be secured as subsequent plan sets are developed.

The City of Wyandotte has proposed a long-term plan to create a district ground source heat pump (DGSHP) service run by the City-owned utility company. The initial stage of this plan will be for each of the NSP2 houses to be equipped with a single well drilled in the boulevard in front of the house. Initially, the wells will provide heating, cooling and domestic hot water for the homes. In the long term, these wells will be linked to form the source/sink for the district system. The efficiency of each of the new and existing houses in the project will in part determine the additional capacity of the DGSHP system that can be sold to residents that were not part of the initial NSP2 program. Therefore, the energy efficiency goals of the housing project are fundamentally connected to the long-term viability of the DGSHP project, creating a further reason to anticipate additional energy savings.

Appendix C: House Plans for Wyandotte NSP2 Pilot Community

Selected drawings for Cedar 1



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NOTE:

SARNACKI & ASSOCIATES ARCHITECTS, INC.

1822 FORD AVENUE ☐ WYANDOTTE, MICHIGAN ☐ 48192
PHONE:(734) 282-3900 FAX:(734) 282-3991 WWW.SARNACKIAIA.COM

DRAWN BY:	DWB
CHECKED BY:	JJS
PROJECT NO.:	2K10-015-A

ISSUED:
CLIENT REVIEW: 08-04-10
CLIENT REVIEW: 08-17-10

213 CEDAR

CLIENT PROJECT NO.: 0389EN WYANDOTTE, MI 48192

A-2

EXTERIOR FINISHES:

T.B.S. = TO BE SELECTED BY OWNER AND ARCHITECT

ASPHALT SHINGLES

CERTAINTEED LANDMARK 30 DIMENSIONAL SHINGLE

FINISH: T.B.S.
MFR: AS SPECIFIED OR ARCHITECT APPROVED EQUAL
WARRANTY: 30 YEAR

SIDING AND TRIM

ALL EXPOSED SIDING, TRIM, AND SOFFIT PANELS TO BE JAMES HARDIE FIBER CEMENT PRODUCTS. SIDING SHALL BE LAP SIDING WITH 4" EXPOSURE

FINISH: SELECT CEDARMILL
COLOR: T.B.S.
WARRANTY: 15 YEAR FINISH
MFR: AS SPECIFIED OR ARCHITECT APPROVED EQUAL

NOTES:

1. ALL LAP SIDING COURSES SHOULD BE ADJUSTED ON EXTERIOR ELEVATIONS AND WALL SECTIONS.
2. SIDING AND TRIM SHALL BE INSTALLED PER MANUFACTURERS RECOMMENDATIONS.

NOTE:

SARNACKI & ASSOCIATES ARCHITECTS, INC.
1822 FORD AVENUE ☐ WYANDOTTE, MICHIGAN ☐ 48192
PHONE:(734) 282-3900 FAX:(734) 282-3991 WWW.SARNACKIAIA.COM

DRAWN BY: DWB
CHECKED BY: AJS
PROJECT NO.: 2K10-015-A

ISSUED:
CLIENT REVIEW: 08-04-10
CLIENT REVIEW: 08-17-10

213 CEDAR
CLIENT PROJECT NO.: 0389EN WYANDOTTE, MI 48192

A-4

Appendix D: Site Visit Reports

2011-06-08 Wyandotte Site Visit Report
2011-06-28 Wyandotte Site Visit Report
2011-08-22 Wyandotte Site Visit Report
2011-10-06 Wyandotte Site Visit Report
Cedar 1 Testing Report

Memo

DATE: June 9, 2011

TO: Betsy Pettit, Building Science Corporation

FROM: Alex Lukachko, BSC

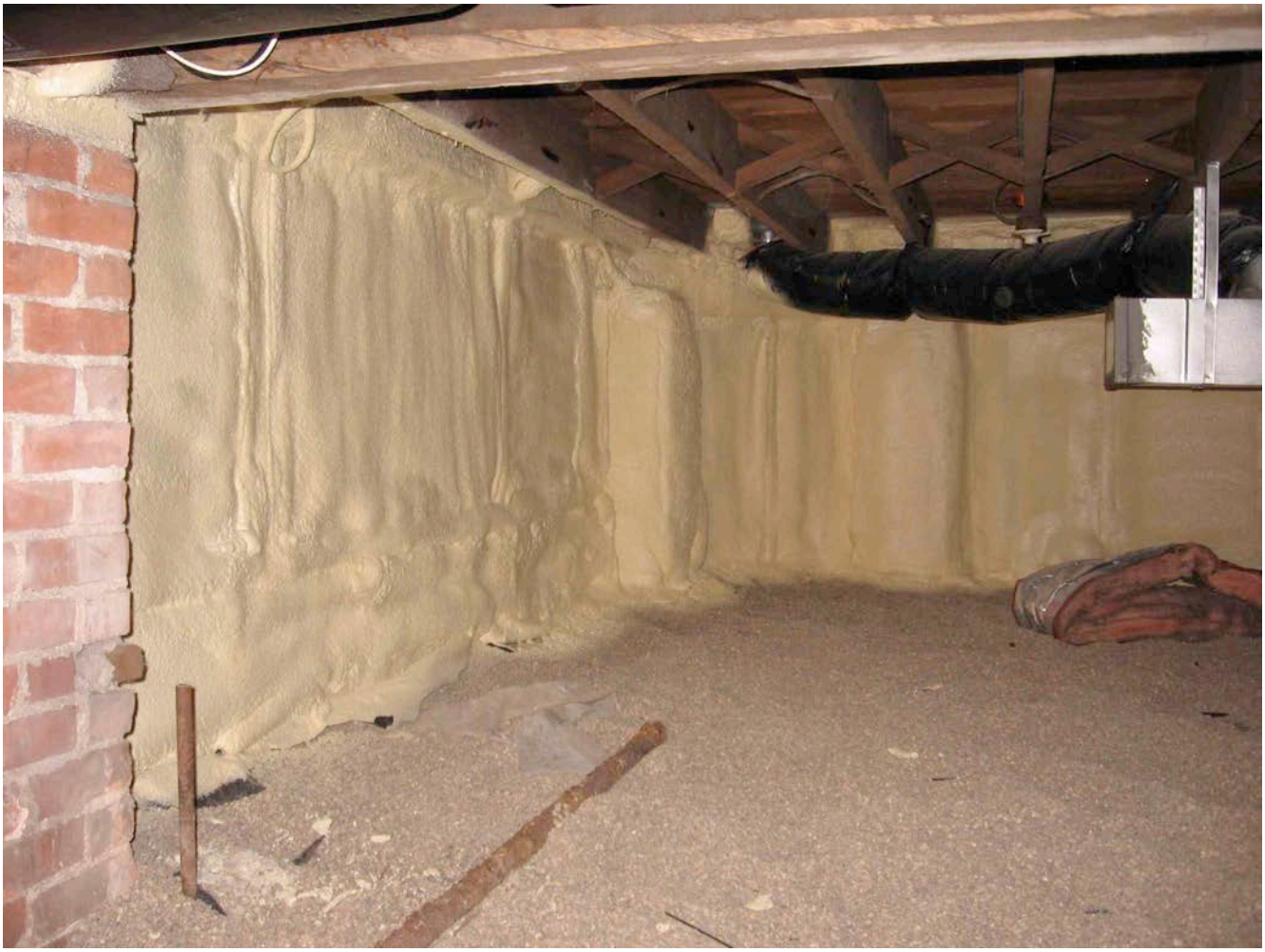
RE: 2011-06-08 Wyandotte Site Visit

CC: Aaron Grin, BSC

Alex Lukachko and Aaron Grin visited the NSP2 project in Wyandotte, MI on June 8, 2011 and made the following observations.

213 CEDAR STREET

This is a Bid Pack 1 retrofit project. Briefly, the house was gutted and refinished on the inside – full depth ccSPF in stud cavities. New mechanical including GSHP. The crawlspace was covered to a conditioned crawlspace. The attic was insulated as a conditioned attic. The roofing was new and left as found. The building was reclad with 1" of XPS and new vinyl. This house is ready for us to test on June 27 but we do not have pre-retrofit data on this house because construction was started during our funding gap.



There is a sheet of polyethylene under the pea gravel.

247 & 257 WALNUT STREET

These are the first two new houses in the NSP2 project. There were a number of changes made to the framing on the first one. Framing of the second house should be smoother. The above-grade portion of the basement foundation wall will be finished with brick and insulated with Thermax on the interior. 2" XPS as insulating sheathing and 3-4" ccSPF on the interior.

The window opening framing will be corrected. They were having some issues with alignment of the framing between walls and floors. This has been largely corrected by the architect. The meeting on-site included the GC, the framing crew, the lumber supplier, the mason, the architects and the City project manager. We talked through all of the details and gave them some guidance on corrections that need to be made. Aaron will issue a brief report to the architect with photos to help them with their site review. A major issue was that no framing drawings were produced. We discussed the value of this and it seems that everyone now understands what level of planning is required for these houses.

Foundations have been built for the second house on the adjacent property.

BID PACK 3 HOUSES

This is the unfinished project that the City purchased. There are two rows of attached houses. The row facing the street (behind this block) is ready for sale with only minor work. The pictured block is finished on the exterior but is completely open to the framing on the inside so significant work can be done on these buildings. Another 4 units will be built on the field in the foreground as part of Bid Pack 3. BSC could include these projects as part of the new construction task.

BID PACK 2 RETROFIT

This house has been assigned as part of Bid Pack 2, which was awarded to the builder who is completing work on the first houses mentioned in this report. This house will be a full rebuild from the interior with minor repairs to the exterior cladding. The basement has obvious water intrusion issues and the City is considering both trenching the exterior to install damproofing and replacing the concrete floor slab to install insulation and a capillary break.

We plan to do a pre-retrofit test on June 27 so that we could use this house as part of the BA retrofit project. However, the work on this project will be done in the fall.

NSP1 RETROFIT HOUSE

This house is not part of the NSP2 project. It is being completed with NSP1 funds and other funding available to the City of Wyandotte and a local non-for-profit development group. The house was moved through the city to this location. It was owned by an important member of the community and has historical significance for the City. 3,500 sq ft plus basement and conditioned attic.

The retrofit work on the interior is largely complete (finishing gypsum board). A new concrete block foundation and floor slab was provided. Insulation of the basement will depend on funding availability. Two ground source heat pump systems were installed, one to service an AHU on the third floor.

The above-grade walls have been filled with ocSPF (they are sending us the product information) and the entire exterior will be clad with XPS and new siding. I have no information about how they plan to tie the windows in to the drainage plane. There are a number of recommendations we could make if we wanted to support this project as part of the program.

The attic space is very much like the Concord house except that they have used 10+ inches of ocSPF and may need a better vapor control strategy.

After having examined this project, I would recommend that we consider providing a set of recommendations for the construction team and making a case study of the project for BA. More significantly, there is good potential here for BASF to support the project given that it is being run by the City and a local group.

Building Science Corporation

Memo

DATE: July 13, 2011

TO: Building Science Corporation, Internal Memo

FROM: Alex Lukachko, BSC

RE: Update on 8.5 Wyandotte, MI Retrofit Project (DRAFT pending final blower door test results)

CC: Aaron Grin, BSC

Alex Lukachko and Aaron Grin visited the NSP2 project in Wyandotte, MI on June 27 and 28, 2011. A map of the Wyandotte NSP2 project area and house locations is available here: http://tinyurl.com/6ftnfwh. Aaron Grin conducted three assessments of existing homes on June 27. An update on each of the retrofit houses is given below.

8.5 WYANDOTTE, MI RETROFIT PROJECT UDPATE

2632 9th Street	
	NSP2 Bid Pack 2 – Existing Home Past updates: 2011-06-27 – Pre-retrofit blower door test

This house has been assigned as part of Bid Pack 2, which was awarded to the builder who is completing work on Bid Pack 1. The City plans to expand the property to include part of a laneway to the north of the house. The house borders a City part to the north.

The retrofit will be a full rebuild from the interior with minor repairs to the exterior cladding. The basement has obvious water intrusion issues and the City is considering both trenching the exterior to install dampproofing and replacing the concrete floor slab to install insulation and a capillary break.

A pre-retrofit blower door test was conducted by Aaron Grin on June 27. The home currently does not have power but a generator was borrowed from Wyandotte Municipal Services. The preliminary blower door result (pending confirmation of the building volume) is 21 ACH

The retrofit work on this project will be done in the fall.

213 Cedar Street	
	NSP2 Bid Pack 2 – Existing Home Past updates: 2010-12-07 – pre-retrofit walk-through 2011-06-08 – retrofit 95% complete 2011-06-27 – Post-retrofit blower door test

This is a Bid Pack 1 retrofit project. The house has been gutted and refinished on the inside – full depth 0.5 pcf ccSPF in the stud cavities. New mechanical systems have been added including GSHP. The existing crawlspace under the front of the house was converted to a conditioned crawlspace. The attic has been insulated as a conditioned attic with 0.5 pcf ccSPF sprayed to the underside of the existing roof deck. The roof cladding was recently replaced and left as found. The exterior walls were reclad with 1" of XPS and new vinyl cladding. Work on the trim and front and back porches has been completed. The second garage on the property has been removed and the side yard will be landscaped.

This house was ready for us to test on June 27 but we do not have pre-retrofit data on this house because construction was started during a 2010/2011 funding gap. The post-retrofit blower door test was conducted by Aaron Grin and a preliminary result of 5 ACH50 was recorded. Several areas for remediation were identified:

- air sealing at rim joist from first to second floor is questionable
- crawlspace air leakage details and uninsulated details
- within the crawlspace, the air seal at the interface between the floor vapor barrier (polyethylene) where it meets foundation pilasters is discontinuous. Instructions were given for remedial measures
- they had put in an outdoor hose bib and there was no air sealing after the SPF was cut away. Sealing is required.

Because of these findings, Ralph Hope (City Project Manager) has decided on a pre-drywall blower door test for each home moving forward to help identify deficiencies earlier in the construction process.

The HERS rater for this house, Stephen Christensen from WARM Training Center, will provide additional photographs and documentation of the retrofit work.

Maple and Third	
	NSP1 – Existing Home Past updates: 2011-06-08 – initial walk-through at retrofit 75% complete 2011-06-27 – post-air barrier blower door test

This house is not part of the NSP2 project. It is being completed with NSP1 funds and other funding available to the City of Wyandotte and a local non-for-profit development group. The house was moved through the city to this location. It was owned by an important member of the community and has historical significance for the City. The house is approximately 3,500 sq ft plus an unfinished basement and partly finished, conditioned attic.

The retrofit work on the interior is largely complete (up to finishing gypsum board). A new concrete block foundation and floor slab was provided. Insulation of the basement will depend on funding availability. Two ground source heat pump systems were installed, one to service an AHU on the third floor. The above-grade walls have been filled with ocSPF and the entire exterior will be clad with XPS and new siding. At this time no information was available about how they plan to tie the windows in to the drainage plane. The attic space is very much like the BSC Concord House retrofit case study except that they have used 10+ inches of ocSPF and may need a better vapor control strategy.

A preliminary diagnostic blower door test was conducted by Aaron Grin to determine areas requiring air sealing. At the time of the test, the SPF insulation had been added to the wall cavities and the attic so the air barrier system was considered to be largely complete. Multiple problem areas were found including preexisting mechanical and electrical penetrations in the rim joist, an area in the basement that was a discontinuous rim joist, and all of the windows require low expansion foam air sealing or caulking depending on the size of the cracks. The preliminary blower door test result was 12-14 ACH50 (to be confirmed when more information about the house is received).

Memo

DATE: September 22, 2011

TO: Building Science Corporation, Internal Memo

FROM: Aaron Grin, BSC

RE: 2011-08-22 Wyandotte Site Visit

CC: Alex Lukachko and Jonathan Smegal, BSC

Aaron Grin and Jonathan Smegal visited the NSP2 project in Wyandotte, MI on August 22, 2011. Twelve sites were visited. The sites ranged level of completion from unchanged since the last visit to poured footings to final landscaping. Each site visited is described below with photo-documentation.

A map of the Wyandotte project area and house locations is available here: http://tinyurl.com/6ftnfwh

HOUSE-BY-HOUSE UPDATES

2632 9th Street	
	NSP2 Bid Pack 2 – Existing Home 2011-06-27 – Pre-retrofit blower door test 2011-08-22 – Unchanged from 2011-06-27 visit

This house has been assigned as part of Bid Pack 2, which was awarded to the builder who is completing work on Bid Pack 1. The City plans to expand the property to include part of a laneway to the north of the house. The house borders a City park to the north. The retrofit work on this project will be done in the fall.

213 Cedar Street	
	NSP2 Bid Pack 2 – Existing Home 2010-12-07 – pre-retrofit walk-through 2011-06-08 – retrofit 95% complete 2011-06-27 – Post-retrofit blower door test 2011-08-22 – Landscaping in process

This is a Bid Pack 1 retrofit project. The house has been gutted and refinished on the inside – full depth 2.0 pcf ccSPF in the stud cavities. New mechanical systems have been added including GSHP. The existing crawlspace under the front of the house was converted to a conditioned crawlspace. The attic has been insulated as a conditioned attic with 2.0 pcf ccSPF sprayed to the underside of the existing roof deck. The roof cladding was recently replaced and left as found. The exterior walls were reclad with 1" of XPS and new vinyl cladding. Work on the trim and front and back porches has been completed. The second garage on the property has been removed and the side yard will be landscaped.

Several areas for remediation were identified during the June 27th visit. During the August 22nd site visit Ralph Hope indicated that construction and repairs would be soon underway and the local representative completing blower door tests would provide BSC with a final blower door test result once the repairs were complete. The contractors were in the process of installing the landscaping in the front yard of the home.

Maple and Third	
	NSP1 – Existing Home 2011-06-08 – initial walk-through at retrofit 75% complete 2011-06-27 – post-air barrier blower door test 2011-08-22 – No significant changes or updates

This house is not part of the NSP2 project. It is being completed with NSP1 funds and other funding available to the City of Wyandotte and a local non-for-profit development group. The house was moved through the city to this location. It was owned by an important member of the community and has historical significance for the City. The house is approximately 3,500 sq ft plus an unfinished basement and partly finished, conditioned attic.

The retrofit work on the interior is largely complete (up to finishing gypsum board). A new concrete block foundation and floor slab was provided. Insulation of the basement will depend on funding availability. Two ground source heat pump systems were installed, one to service an AHU on the third floor providing space conditioning to the second floor and attic while the AHU located in the basement serving the basement and main floor. The above-grade walls have been filled with pour-installed ocSPF and the entire exterior will be clad with XPS and new siding. At this time no information was available about how they plan to tie the windows in to the drainage plane. The attic space is very much like the BSC Concord House retrofit case study except that they have used 10+ inches of ocSPF and may need a better vapor control strategy.

456 Vinewood	
	NSP2 Bid Pack 2 – New Construction 2011-06-28 – footings complete
 	2011-08-22 – Framing nearing completion. Electrical, mechanical, and plumbing started

During the August 22nd visit the framing of 456 Vinewood was reviewed. It was found that a new structural sheathing product was being used on this home. The structural OSB sheathing appears to have been replaced with Dow SIS although this could not be confirmed as the labeled side of the product is covered on the outside.

In terms of advanced framing the learning curve for this builder is evident on this home as very little was found in terms of deficiencies. The main deficiency found was the unnecessary installation of relatively heavy-duty manufactured headers above windows in non-load bearing walls. This was found on both the front and back of the house where it appears these walls are in gables and are non-load bearing. The removal of these headers has the potential to reduce construction costs. These findings were discussed with Tony Pizzo of Pizzo Construction. These findings will be discussed with Sarnacki Architects.

	2011-08-22 – Unnecessary header above a window in a non-load bearing wall

115 Poplar	
	NSP2 Bid Pack 2 – New Construction 2011-06-28 – foundation complete
	2011-08-22 – Framing nearing completion. Electrical, mechanical, and plumbing started

During the August 22nd visit the framing of 115 Poplar was reviewed. Similar to the home on Vinewood, this framing package also contained a few headers in non-load bearing walls. These findings will be discussed with Sarnacki Architects.

A window on the second floor had not been installed yet allowing a review of the sub-sill flashing. Care must be taken to ensure reversed flashings, gaps, or fish mouths do not occur. Shown in the photo below, a gap has been left in the corner flashing of the sub-sill flashing. This has the potential to direct water on the subsill flashing behind the insulating sheathing which is intended to be the drainage plane. This has the potential to cause moisture related damage to the structural sheathing.

	2011-08-28 – Gap in corner flashing

A new method of creating a back-dam on the sill was seen in this house. A back dam is used to ensure that water sitting on the sub-sill flashing cannot enter the home. In this installation a 3/8” foam backer rod was used below sub sill flashing to create this upturn. Although this has the possibility to work, it appeared that the foam backer rod did not adhere well to the flashing tape and hence did not stay in place. Alternatively a small strip of wood (or plywood) could be affixed across the full width of the rough opening and the flashing tape lapped onto the wood. This would help ensure the flashing tape has a secure, fixed substrate that has good adhesion to the tape.

	2011-08-28 – Backer rod back-dam failing to adhere to the flashing tape

247 Walnut	
	NSP2 Bid Pack 1 – New Construction 2011-06-08 - AF 50% complete, changes recommended 2011-06-28 - AF 98% complete, window flashing 2011-08-22 – Framing complete. Electrical, mechanical, and plumbing started

This is the first new house in the NSP2 project. On the 2011-06-08 site visit, framing was approximately 50% complete and there were a number of changes recommended. On the August 22nd visit the framing was complete and the electrical, mechanical and plumbing had been started.

Water management details at the windows need some improvement - flashing was observed to be sealing the bottom of the window, rather than being drained. It was recommended that the flashing across the bottom of the window be slit or removed completely. BSC also recommended back dams on window openings. As recommended the flashing across the bottom of the window was removed in most areas. The east facing windows of the home on the first and second floor still require that the flashings along the bottoms of the windows be removed. There also areas within the field of the wall where the joints between the sheets of XPS must be sealed as the primary drainage plane. The windows above the front porch also require attention to repair the flashings.

	Flashing at the bottom of the window removed

	Areas where flashings below the windows need to be removed
	Windows above front porch requiring remediation
	Areas in the field of the wall that require tape sealing

It was also noted on this house that the garage was framed as standard with 16” on centre framing. Savings could be found if the framing was reduced in the garages.

	Garage framing at 16” on centre.

257 Walnut	
	NSP2 Bid Pack 1 – New Construction 2011-06-08 - Foundation complete 2011-06-28 - Framing and insulating sheathing 95% complete 2011-08-22 – Framing complete. Electrical, mechanical, and plumbing started

The repairs recommended in July were substantially completed where possible. During the August 22nd site visit few additional issues were found. The primary concern is the continuity of the drainage plane. The tape was no longer adhered to the insulation as a drainage plane and the step flashing over the room at the back of the house needs to be integrated to the drainage plane. Finally a small hole was found in the venting. This hole appears to have been created by another trade drilling holes to run wiring. It is important that these deficiencies be repaired.

	Failing and completely missing tape
	Step flashing requiring integration to the drainage plane. Details to finish this flashing with a regletted cap flashing and tape can be found at: http://www.buildingscience.com/documents/information-sheets/common-flashing-details/files/bsc_info_303_common_flashing.pdf
	Venting hole requiring foil tape repair

2445 Cora Street (2250 or 2445)	
	2011-08-22 – Foundation complete, capillary break not apparently present

During the August 22nd site visit it was found that the block foundation was complete for this house. Exterior parging and damproofing were complete but a footing capillary break did not appear to be present.

2446 8th Street (South, west side of the road)	
	2011-08-22 – Footings complete with capillary break

During the August 22nd site visit it was found that the footings were complete for this house. A capillary break was adequately installed in the form of a roller applied product.

2406 8th Street (Mid, west side of the road)	
	2011-08-22 – Foundation complete, missing capillary break

During the August 22nd site visit it was found that the block foundation was complete for this house. Exterior parging and damproofing were complete but a footing capillary break did not appear to be present.

2325 8th Street (North, east side of the road)	
	2011-08-22 – Footings complete missing capillary break

During the August 22nd site visit it was found that the footings were complete for this house. A capillary break not installed for on this footing. This information was relayed to Ralph Hope for remediation.

234 Chestnut	
	2011-08-22 – Foundation and basement floor complete. The status of the capillary break is unknown
	2011-08-22 – Drilling of the geothermal wells in progress

During the August 22nd site visit it was found that the poured foundation was complete for this house. Exterior damproofing was complete but it could not be determined if a footing capillary break was installed as the basement slab was already poured.

472 Cedar Street (west, near tracks)	
 	2011-08-22 – Foundation and basement floor complete. It appears that the capillary break was not properly installed between the footing and the foundation.
	2011-08-22 – Foundation crack

During the August 22nd site visit it was found that the poured foundation was complete for this house. Exterior damproofing was complete but it appeared that the footing capillary break was improperly installed at the inside joint between the footing and the foundation rather than between the footing and the foundation before the foundation was poured. The crack appears to be due to the fact that the foundation was back filled before the floor of the house was installed and, as reported by Ralph Hope, before shoring was installed.

Memo

DATE: October 14, 2011

TO: Building Science Corporation, Internal Memo

FROM: Aaron Grin, BSC

RE: 2011-10-06 Wyandotte Site Visit

CC: Alex Lukachko, BSC

Aaron Grin and Alex Lukachko visited the NSP2 project in Wyandotte, MI on October 6th, 2011. The sites ranged level of completion from unchanged since the last visit to poured footings to final landscaping. Each site visited is described below with photo-documentation.

A map of the Wyandotte project area and house locations is available here: http://tinyurl.com/6ftnfwh

HOUSE-BY-HOUSE UPDATES

2632 9th Street	
	NSP2 Bid Pack 2 – Existing Home 2011-06-27 – Pre-retrofit blower door test 2011-08-22 – Appeared unchanged from 2011-06-27 visit 2011-10-06 – Appeared unchanged from 2011-08-22 visit

This house has been assigned as part of Bid Pack 2, which was awarded to the builder who is completing work on Bid Pack 1. The City plans to expand the property to include part of a laneway to the north of the house. The house borders a City park to the north. The retrofit work on this project will be done in the fall and winter 2011-2012.

213 Cedar Street	
	NSP2 Bid Pack 2 – Existing Home 2010-12-07 – pre-retrofit walk-through 2011-06-08 – retrofit 95% complete 2011-06-27 – Post-retrofit blower door test 2011-08-22 – Landscaping in process 2011-10-06 – Post-repairs blower door test

This is a Bid Pack 1 retrofit project. The house has been gutted and refinished on the inside – full depth 2.0 pcf ccSPF in the stud cavities. New mechanical systems have been added including GSHP. The existing crawlspace under the front of the house was converted to a conditioned crawlspace. The attic has been insulated as a conditioned attic with 2.0 pcf ccSPF sprayed to the underside of the existing roof deck. The roof cladding was recently replaced and left as found. The exterior walls were reclad with 1" of XPS and new vinyl cladding. Work on the trim and front and back porches has been completed. The second garage on the property has been removed and the side yard will be landscaped.

Several areas for remediation were identified during the June 27th visit. During the August 22nd site visit Ralph Hope indicated that construction and repairs would be soon underway and the local representative completing blower door tests would provide BSC with a final blower door test result once the repairs were complete. The contractors were in the process of installing the landscaping in the front yard of the home.

A post repair blower door test was completed. The test showed that there was an improvement to the home with the repairs completed in the un-insulated basement. Although the un-insulated basement was repaired, the crawlspace issues discussed with Ralph Hope during the June 8th review were not addressed. It was also likely not feasible to remove finished drywall to find the 1st to 2nd floor rim joist leakage areas, hence these leakage points remain. The air leakage during the October 6th visit was found to be 1833CFM at 50Pa.

Maple and Third	
	NSP1 – Existing Home 2011-06-08 – initial walk-through at retrofit 75% complete 2011-06-27 – post-air barrier blower door test 2011-08-22 – No significant changes or updates 2011-10-06 – Did not review this site during this site visit

This house is not part of the NSP2 project. It is being completed with NSP1 funds and other funding available to the City of Wyandotte and a local non-for-profit development group. The house was moved through the city to this location. It was owned by an important member of the community and has historical significance for the City. The house is approximately 3,500 sq ft plus an unfinished basement and partly finished, conditioned attic.

The retrofit work on the interior is largely complete (up to finishing gypsum board). A new concrete block foundation and floor slab was provided. Insulation of the basement will depend on funding availability. Two ground source heat pump systems were installed, one to service an AHU on the third floor providing space conditioning to the second floor and attic while the AHU located in the basement serving the basement and main floor. The above-grade walls have been filled with pour-installed ocSPF and the entire exterior will be clad with XPS and new siding. At this time no information was available about how they plan to tie the windows in to the drainage plane. The attic space is very much like the BSC Concord House retrofit case study except that they have used 10+ inches of ocSPF and may need a better vapor control strategy.

456 Vinewood	
	NSP2 Bid Pack 2 – New Construction 2011-06-28 – footings complete
 	2011-08-22 – Framing nearing completion. Electrical, mechanical, and plumbing started
	2011-10-06 – Mechanical and electrical substantially installed

	Step flashing requiring integration to the drainage plane. Details to finish this flashing with a regletted cap flashing and tape can be found at: http://www.buildingscience.com/documents/information-sheets/common-flashing-details/files/bsc_info_303_common_flashing.pdf

During the August 22nd visit the framing of 456 Vinewood was reviewed. It was found that a new structural sheathing product was being used on this home. The structural OSB sheathing appears to have been replaced with Dow SIS although this could not be confirmed as the labeled side of the product is covered on the outside.

In terms of advanced framing the learning curve for this builder is evident on this home as very little was found in terms of deficiencies. The main deficiency found was the unnecessary installation of relatively heavy-duty manufactured headers above windows in non-load bearing walls. This was found on both the front and back of the house where it appears these walls are in gables and are non-load bearing. The removal of these headers has the potential to reduce construction costs. These findings were discussed with Tony Pizzo of Pizzo Construction. These findings will be discussed with Sarnacki Architects.

	2011-08-22 – Unnecessary header above a window in a non-load bearing wall

115 Poplar	
	NSP2 Bid Pack 2 – New Construction 2011-06-28 – foundation complete
	2011-08-22 – Framing nearing completion. Electrical, mechanical, and plumbing started

	2011-10-06 – Mechanical and electrical work continues

During the August 22nd visit the framing of 115 Poplar was reviewed. Similar to the home on Vinewood, this framing package also contained a few headers in non-load bearing walls. These findings will be discussed with Sarnacki Architects.

A window on the second floor had not been installed yet allowing a review of the sub-sill flashing. Care must be taken to ensure reversed flashings, gaps, or fish mouths do not occur. Shown in the photo below, a gap has been left in the corner flashing of the sub-sill flashing. This has the potential to direct water on the subsill flashing behind the insulating sheathing which is intended to be the drainage plane. This has the potential to cause moisture related damage to the structural sheathing.

	2011-08-28 – Gap in corner flashing

A new method of creating a back-dam on the sill was seen in this house. A back dam is used to ensure that water sitting on the sub-sill flashing cannot enter the home. In this installation a 3/8" foam backer rod was used below sub sill flashing to create this upturn. Although this has the possibility to work, it appeared that the foam backer rod did not adhere well to the flashing tape and hence did not stay in place. Alternatively a small strip of wood (or plywood) could be affixed across the full width of the rough opening and the flashing tape lapped onto the wood. This would help ensure the flashing tape has a secure, fixed substrate that has good adhesion to the tape.

	2011-08-28 – Backer rod back-dam failing to adhere to the flashing tape

247 Walnut	
	NSP2 Bid Pack 1 – New Construction 2011-06-08 - AF 50% complete, changes recommended 2011-06-28 - AF 98% complete, window flashing 2011-08-22 – Framing complete. Electrical, mechanical, and plumbing started
	2011-10-06 – Siding, mechanical, drywall and interior finishes underway. Blower door test completed.

This is the first new house in the NSP2 project. On the 2011-06-08 site visit, framing was approximately 50% complete and there were a number of changes recommended. On the August 22nd visit the framing was complete and the electrical, mechanical and plumbing had been started.

Water management details at the windows need some improvement - flashing was observed to be sealing the bottom of the window, rather than being drained. It was recommended that the flashing across the bottom of the window be slit or removed completely. BSC also recommended back dams on window openings. As recommended the flashing across the bottom of the window was removed in most areas. The east facing windows of the home on the first and second floor still require that the flashings along the bottoms of the windows be removed. There also areas within the field of the wall where the joints between the sheets of XPS must be sealed as the primary drainage plane. The windows above the front porch also require attention to repair the flashings.

	Flashing at the bottom of the window removed

	Areas where flashings below the windows need to be removed
	Windows above front porch requiring remediation
	Areas in the field of the wall that require tape sealing

It was also noted on this house that the garage was framed as standard with 16” on centre framing. Savings could be found if the framing was reduced in the garages.

	Garage framing at 16” on centre.

The flashing issues on the second floor bathroom windows reported on during the August visit still require repair.

A blower door test was completed during the October site visit. The air leakage during the October 6th visit was found to be 1023CFM at 50Pa. Although this result is not poor, there is still room for improvement. As indicated in the Home Energy Survey by Steve Christensen, it appeared that the leakage was coming from the area around the kneewall at the dormer on

the second floor and around the eves. It is critical to ensure that the spray foam from against the roof deck continue down to the top top-plate of the wall assembly or the floor/rim of the second floor. The spray foam within the rim or the wall system will then continue the air barrier. The goal for a fully spray foamed home with a simple plan should be in the range of 300 to 500 CFM at 50Pa, 1/3 to ½ of what was attained at this home.

257 Walnut	
	NSP2 Bid Pack 1 – New Construction 2011-06-08 - Foundation complete 2011-06-28 - Framing and insulating sheathing 95% complete 2011-08-22 – Framing complete. Electrical, mechanical, and plumbing started
	2011-10-06 – Siding, mechanical, drywall and interior finishes underway.

The repairs recommended in July were substantially completed where possible. During the August 22nd site visit few additional issues were found. The primary concern is the continuity of the drainage plane. The tape was no longer adhered to the insulation as a drainage plane and the step flashing over the room at the back of the house needs to be integrated to the drainage plane. Finally a small hole was found in the venting. This hole appears to have been created by another trade drilling holes to run wiring. It is important that these deficiencies be repaired.

	Failing and completely missing tape
	Step flashing requiring integration to the drainage plane. Details to finish this flashing with a regletted cap flashing and tape can be found at: http://www.buildingscience.com/documents/information-sheets/common-flashing-details/files/bsc_info_303_common_flashing.pdf

	Venting hole requiring foil tape repair

2445 Cora Street	
	2011-08-22 – Foundation complete, capillary break not apparently present 2011-10-06 – First floor floor framing complete

During the August 22nd site visit it was found that the block foundation was complete for this house. Exterior parging and damproofing were complete but a footing capillary break did not appear to be present. During the October site visit it was found that the first floor floor framing was complete.

2446 8th Street (South, west side of the road)	
	2011-08-22 – Footings complete with capillary break 2011-10-06 – Foundation complete, nothing else to report

During the August 22nd site visit it was found that the footings were complete for this house. A capillary break was adequately installed in the form of a roller applied product. It was observed during the October visit that the foundation for this house was installed.

2406 8th Street (Mid, west side of the road)	
	2011-08-22 – Foundation complete, missing capillary break 2011-10-06 – Foundation complete, nothing else to report

During the August 22nd site visit it was found that the block foundation was complete for this house. Exterior parging and damproofing were complete but a footing capillary break did not appear to be present. It was observed during the October visit that the foundation for this house was installed.

2325 8th Street (North, east side of the road)	
	2011-08-22 – Footings complete missing capillary break 2011-10-06 – Foundation complete, nothing else to report

During the August 22nd site visit it was found that the footings were complete for this house. A capillary break not installed for this footing. This information was relayed to Ralph Hope for remediation. It was observed during the October visit that the foundation for this house was installed.

234 Chestnut	
	2011-08-22 – Foundation and basement floor complete. The status of the capillary break is unknown 2011-10-06 – Site not visited during this trip
	2011-08-22 – Drilling of the geothermal wells in progress

During the August 22nd site visit it was found that the poured foundation was complete for this house. Exterior damproofing was complete but it could not be determined if a footing capillary break was installed as the basement slab was already poured. This site was not visited during the October site visits.

472 Cedar Street (west, near tracks)	
 	2011-08-22 – Foundation and basement floor complete. It appears that the capillary break was not properly installed between the footing and the foundation.
	2011-08-22 – Foundation crack
	2011-10-06 – Framing substantially complete. Insulated sheathing was removed in locations to determine fastening pattern for SIS.

During the August 22nd site visit it was found that the poured foundation was complete for this house. Exterior damproofing was complete but it appeared that the footing capillary break was improperly installed at the inside joint between the footing and the foundation rather than between the footing and the foundation before the foundation was poured. The crack appears to be due to the fact that the foundation was back filled before the floor of the house was installed and, as reported by Ralph Hope, before shoring was installed.

During the October site visit this site seemed to be in a state of disassembly and repair. Sections of roofing were left uninstalled. Areas of the exterior insulation and SIS had been removed while the electrical and mechanical was at rough-in.

2250 Cora Street	
	2011-10-06 – Foundation complete, framing nearing completion.

During the October site visit this house was found to be nearing framing completion. This was a first try for the framer on-site and overall there were very few issues with the home. Some design issues were determined on-site, but do not require major repair. 1" of exterior insulation is used on this home because the design created for this home was developed during the initial design process with the city of Wyandotte when it was unclear how much funding would be available for energy saving upgrades. During the construction process it was found that the construction would be significantly simplified and increase the available headroom on the second floor if the two planned dormers became one large dormer as shown in the photo above. This framing package is the first completed that has a hung main floor framing system to minimize the rise of the first floor from grade allowing this unit to be fully wheelchair accessible.

Vinewood Condos	
	2011-10-06 – Preliminary walk through completed of units without drywall or insulation. Blower door test completed of a single interior unit which was substantially complete.

A finished blower door test was completed on October 6th. The results of this blower door test showed an estimated leakage rate of 1803 CFM at 50Pa. This correlates to an approximate 5 ACH at 50Pa. Areas of leakage found included the window to window rough framing where it appears no sealant is provided and interior partitions on the second floor which connect to the attic space. The windows should be sealed with low expansion foam while the partitions intersecting the attic space should be sealed with closed cell spray foam from the attic side. It is likely that the rim joists are also sources of leakage, but to seal this area would require removal of interior drywall to properly seal.

Blower Door Testing Summary

During site visits BSC completed blower door tests as they coincided with various stages of construction. The first set of blower door tests were completed on June 27th 2011. During this visit tests were completed on 2632 9th Street (existing home), 213 Cedar St (existing home), and the Century Home at Maple and Third (existing home). The 9th Street test was a pre-retrofit test while the Cedar and Century homes were post-retrofit. Upon completion of the tests the results and leakage areas were discussed on-site with Ralph Hope who made notes about required repairs or areas of concern. The second set of blower door tests was completed on October 6th. This testing included a re-test of 213 Cedar, a new interior townhome in the Vinewood Condos as well as a finished blower door test of 247 Walnut. The testing of 213 Cedar showed a small improvement although not all of the recommended repairs were completed. 247 Walnut was the first final blower door test of a new home built under the NSP2 project. This test showed promise as it was substantially lower than the other retrofitted homes, but there is room for improvement and leakage areas are indicated in the tables below. The following tables summarize the blower door tests completed to-date by BSC as well as areas of leakage and recommended remediation. It is strongly recommended for all homes that a pre-drywall blower door test be completed to source and repair air leakage areas before the drywall is installed.

Address
2632 9th Street
House Type
NSP2 Bid Pack 2 - Existing Home
Blower Door Results
The initial pre-retrofit blower door test was completed on June 27th. The results of this blower door test showed a leakage rate of 4269 CFM at 50Pa. This correlates to an approximate 21 ACH at 50Pa. Areas of significant leakage include the attic floor, the basement rim joist, existing windows, kneewall attic access hatches, and unsealed abandoned chimney.

Address
213 Cedar Street
House Type
NSP2 Bid Pack 2 – Existing Home
Blower Door Results

A post-retrofit blower door test was completed on June 27th. The results of this blower door test showed a leakage rate of 2135 CFM at 50Pa. This correlates to an approximate 5.2 ACH at 50Pa.

Areas of significant leakage include the first floor to second floor rim joist, cracks in the uninsulated basement, missing details on the crawlspace spray foam application, unsealed details where the spray foam meets the floor polyethylene, and penetrations installed post spray foaming. These areas were discussed with Ralph Hope on-site. In order to air seal the uninsulated basement, air sealing and insulating the area was recommended. To detect and repair air leakage areas it is recommended that a blower door test be completed prior to drywalling the interior of each house. This will facilitate detection AND subsequent repair of leakage areas.

A post repair blower door test was completed. The results of this blower door test showed a leakage rate of 1833 CFM at 50Pa. This correlates to an approximate 4.5 ACH at 50Pa. Although this shows an improvement, some of the recommended repairs were not completed. The missing spray foam at certain areas of the rim-sill plate intersection in the crawlspace remain as well as unsealed details where the spray foam meets the floor polyethylene.

Address

Century Home at Maple and 3rd St.

House Type

NSP1 – Existing Home

Blower Door Results

A post-retrofit blower door test was completed on June 27th. The results of this blower door test showed an estimated leakage rate of 7500 CFM at 50Pa. This correlates to an approximate 9 ACH at 50Pa.

Areas of significant leakage include window rough framing to window bucks, gaps and cracks in the uninsulated basement and rim joist, and unsealed penetrations.

Address

247 Walnut Street

House Type

NSP2 Bid Pack 1 – New Construction

Blower Door Results

A semi-finished blower door test was completed on October 6th. The results of this blower door test showed an estimated leakage rate of 1023 CFM at 50Pa. This correlates to an approximate 3 ACH at 50Pa.

Although this result is not poor, there is still room for improvement. As indicated in the Home Energy Survey by Steve Christensen, it appeared that the leakage was coming from the area around the kneewall at the dormer on the second floor and around the eves. It is critical to ensure that the spray foam from against the roof deck continue down to the top top-plate of the wall assembly or the floor/rim of the second floor. The spray foam within the rim or the wall system will then continue the air barrier. The goal for a fully spray foamed home with a simple plan should be in the range of 300 to 500 CFM at 50Pa - 1/3 to ½ of what was attained at this home.

Address

Vinewood Condos - Interior Unit

House Type

NSP2 Bid Pack 1 – New Construction

Blower Door Results

A finished blower door test was completed on October 6th. The results of this blower door test showed an estimated leakage rate of 1803 CFM at 50Pa. This correlates to an approximate 5 ACH at 50Pa.

Areas of leakage found included the window to window rough framing where it appears no sealant is provided and interior partitions on the second floor which connect to the attic space. The windows should be sealed with low expansion foam while the partitions intersecting the attic space should be sealed with closed cell spray foam from the attic side. It is likely that the rim joists are also sources of leakage, but to seal this area would require removal of interior drywall to properly seal.

SNAPSHOT© "The Form"

Lot #: '---	Subdivision:	Address:	Date and time:
Model: Retrofit	Wyandotte NSP2	213 Cedar, Wyandotte	2011/11/28 ~3pm

INITIALIZATION

	Square feet	1575 sq. ft.
	Surface area (all outside surfaces, including foundation)	5500 sq. ft.
	Volume	18792 cu. ft.
	Windspeed (approximate mph)	15-20 mph
	Outside temperature (estimated)	° F
	Check that all registers and bedroom doors are open.	Yes☒ No☐
	Measure static pressure in return between fan & filter.	Did Not Complete pa
	Static pressure in Supply and Return	S 31.1Pa / R -21.9Pa
	Is there a ventilation system?	Yes☒ No☐
	Type of ventilation system (e.g., exhaust-only, HRV, ERV)	Outside Air Duct
	If there is an AirCycler™, enter the off / on times.	off -- on --
	Enter outside air duct pressure.	-7.2 pa
	Type of outside air duct (flex/sheet metal; diameter)	6" Insulated Flex
	Is there an adjustable outside air damper?	Yes☐ No☒
	Is there a fireplace or wood stove?	Yes☐ No☒
	Duct location (approximate % in attic, conditioned space, basement, etc.)	100% Indoors

PRESSURE and FLOW TESTING

	Stack Pressure (baseline with blower door installed; covers on)			-4.2 pa	
	Dominant Duct Leak Effect (baseline with HVAC system running)			-4.2 pa	
	Master Bedroom Door Closure Effect (ΔP from main space to outdoors)			No change pa	
	All Doors Closed Effect (ΔP from main space to outdoors)			No change pa	
	Fireplace/Wood Stove Zone HVAC Test			No change pa	
	Pressure In Each Closed Room (room label and pressure)	Main Floor Bath	+2.9 pa		pa
		Bedroom 1	+0.9 pa		pa
		Bedroom 2	+0.9 pa		pa
		Bedroom 3	+0.3 pa		pa
		2nd Floor Bath	+0.4 pa		pa
	Exhaust Fan Flow	Main Floor Bath	51 CFM		
		2nd Floor Bath	48 CFM		
	Supply Register Flows	Dining Room	85 CFM	Bedroom 1	44 CFM
		Living Room A	69 CFM	Bedroom 2	52 CFM
		Living Room B	76 CFM	Bedroom 3	20 CFM

BLOWER DOOR TESTING (BDT)

	Blower Door Location	Front Door
	Total CFM50 (add C & n values if available on multipoint test)	CFM50= 1860 C= 159.4 n= .628

DUCT AIRTIGHTNESS TESTING (DAT)

	DAT CFM25 TOTAL	1997 CFM @ -18.1 Pa
	DAT CFM25 OUTSIDE	127 CFM

MECHANICALS

	Furnace or air handler	Make: Water Furnace	Model: NDV026B111CTR
	Air Conditioning	Make:	Model:
	Domestic hot water	Make: Bradford White	Model: M2HE50S6DS-1NCWW

Appendix E: Press Reports

Wyandotte Showcases First Home Renovated Through $8M Federal Grant Program

An open house for the three-bedroom home at 213 Cedar is set for 10 a.m. to 6 p.m. Oct. 16.

By Paula Evans Neuman | Email the author | October 3, 2011

Related Topics: Neighborhood Stabilization Program 2

Interested in a follow-up to this article? Enter your en

« Back to Dispatches

The federal government awarded Wyandotte nearly $8 million last year to improve the city's housing stock

That work has now come to fruition with the announcement that the first of 44 houses to go through the N to go on the market to be sold.

The three-bedroom house at 213 Cedar was built in 1893. It has big front and back porches, a two-car ga appliances and a brand-new geothermal heating and cooling system that will cost the homeowner only $2

be given from 10 a.m. to 6 p.m. Oct. 16.

The house was purchased out of foreclosure by the city, completely remodeled from stem to stern—pluml qualifying low-income family through a lottery process mandated by the federal grant money that makes t

"This house was totally gutted all the way down to the studs," said architect Jay Sarnecki of Sarnecki & A two-family house."

He sounds proud when he talks about the project, and about the other homes he has worked on that will income families through the program.

Wyandotte Is One of a Lucky Few

The program began last year, when Wyandotte got $7.8 million in neighborhood stabilization grant money Urban Development. The city is using it to buy abandoned, vacant and foreclosed properties. Wyandotte state and 56 entities—cities or states—nationwide that got the grant money, and officials are on target wit of the funds to revitalize Wyandotte's neighborhoods.

Some houses, including a rental unit next to 213 Cedar, are being torn down, and new homes are being b sites. Others, such as the Cedar Street home, are being rehabilitated.

Energy efficiency is a major player in the process, and each of the 44 homes will have a new geothermal h insulation, new windows and Energy Star appliances. The eventual homeowners will benefit from the gran energy efficiency.

"We can save them a lot through lower utilities," said City Engineer Mark Kowalewski.

Geothermal heating and cooling starts with the drilling of a narrow 300-foot well. The temperature undergr how hot or cold the weather gets on the surface. The geothermal system works as a closed loop, circulati extract that consistent heat from the ground, compress it and distribute it through a heat pump and duct s the same procedure in reverse, taking heat from the air of the house and moving it into the earth loop.

The system is "carbon neutral," Kowalewski said, and is quieter than a regular furnace system, as well.

"You save quite a bit on your hot water, too," he said.

Wyandotte also is making use of "advanced framing" building techniques, which reduce the amount of lur increase the amount of insulation used. The city, working with Building Science Corp., has had to conduct project to teach them the new and more sustainable advanced framing techniques, which have proven to

Michigan State Housing Development Authority regulators are so impressed with the geothermal and adva incorporating into the home rehabilitation and construction that they've asked city officials for a presentati

"We're going to set up a webinar on geothermal and advanced framing," Kowalewski said. "Hopefully, MS housing."

The first 25 percent of the Wyandotte homes readied for the market through the grant program must be s $23,250 a year for a one-person household to $43,850 a year for a household of eight adults. The rest will buyers. The moderate-income range starts at $55,800 for a one-person household and goes to $105,240

How to Apply

- Pick up an application from the Engineering Department at **City Hall**. Fill it out and return it with the re
- Once your income is verified as eligible under program guidelines, officials will look at your credit ratir credit repair counseling to raise it, and try again. If your credit rating is acceptable, your application (for be submitted to the city's approved home counseling agency—Lighthouse of Oakland County.
- You then must take an eight-hour course on buying a home—four hours of classroom work that will b **Library**, and four individual hours. The counselors will help to determine how much of a mortgage you c comes off your required 1 percent down payment.
- Then you submit a purchase agreement, a mortgage price and your class certificate to the city, and y the homes in the program.
- If your name is drawn, congratulations! You can buy the house. If not, you're back in the lottery for the become available.

The homes are a bargain, to say the least. Take the one at 213 Cedar that's on the market now. The city ha remodeling. The house is appraised for $100,000, setting that as the purchase price. Applicants through t additional discount, as well.

"Therefore, the maximum purchase price is $82,500," said Santina Daly, the city's marketer for the prograı

The price includes a range, dishwasher, microwave oven and a washer and dryer—all energy-efficient, of c phone, cable TV and Internet service.

"We'll be accepting applications until February 2013, " Daly said.

Money from selling the houses goes back into the program.

How does the city benefit?

"It gets the properties back on the tax rolls, and cleans up blight," Daly said.

Vacant homes in foreclosure bring down everyone's property values, Kowalewski said, adding that the nev

The program also creates jobs, putting builders and other people to work, and helps the economy in gene

The News Herald (**thenewsherald.com**), The Voice of Downriver

News

WYANDOTTE: Two years later, $7.8 million Neighborhood Stabilization Program begins to take seed

Wednesday, October 5, 2011

By Jim Kasuba

WYANDOTTE — Almost two years ago, the city received $7.8 million in federal funds for a Neighborhood Stabilization Program that is now taking seed.

The first of 44 houses or renovated condominiums is on the market, a tangible sign of the benefit the city received when it was awarded the grant.

The first house the city is showcasing is at 213 Cedar, two blocks south of Ford Avenue, between Second and Third streets.

The first of two open houses was held Sunday, and based on the number of people who showed up to tour it, interest in the program is strong.

“I was overwhelmingly busy,” said Jerry Miller, owner of Downriver Real Estate Group, the Wyandotte-based company chosen to market all NSP2 houses in the city. “Open houses have pretty much been a thing of the past.”

That might be true for a typical sale in today’s market, but NSP2 houses are anything but typical.

For one thing, this house can only be sold to a qualified low-income buyer. Miller said the first 25 percent of NSP2 houses must come from this category; However, after that goal has been achieved, the rest can be sold to low- or moderate-income buyers.

The definition of low income is a household income at or below 50 percent of the area median income, and it also is based on number of people in the household.

Another thing not typical about this sale is that people who are not necessarily interested in buying the house attended the first open house, and the same probably will be true for a second one, slated for 10 a.m. to 6 p.m. Oct. 16.

Miller said about 40 groups of people went through the house Sunday. He said they asked questions about the program itself, about the geothermal power that is being used for all NSP2 houses and commented on what they viewed as a first-rate renovation.

“I received very positive feedback,” Miller said. “People were going on about the quality of the home.”

The geothermal aspect of the project is another thing that makes it unique from any other houses that have been rehabilitated or constructed in the city in the past.

City Engineer Mark Kowalewski said the geothermal project is believed to be the first for residential customers in this part of the state.

The first NSP grant the city received was for $560,000, allocated as part of a federal Community Development Block Grant.

Wyandotte used its grant money for a relatively small project — the rehabilitation of a house on Lindbergh and another on Lincoln, the first to utilize geothermal energy.

Last year, the City Council approved the creation of a geothermal utility. Although the cost of installing a system is relatively expensive, its efficiency saves homeowners money in the long run.

“We can save them a lot through lower utilities,” Kowalewski said.

A geothermal utility works by circulating water through pipes buried deep in the ground, where temperatures are a constant 54 to 56 degrees. The water is heated or cooled to a desired temperature, depending on whether it’s winter or summer.

It costs about $8,000 to drill a 300-foot well to tap into that energy, and another $12,000 for a heat pump, considerably more expensive than a new furnace or air-conditioning unit.

But after those initial costs, the consumer doesn’t need to use natural gas. The estimated cost for geothermal is $28 per month. There is no gas bill for heating, but gas still will be available if the homeowner chooses to be connected.

Kowalewski said many people ask about what the furnace and ducts look like on a geothermal system, but based on the one installed at the Cedar house, the furnace and hot water tank don’t look drastically different than conventional ones.

Although the use of government stimulus funds draws mixed reactions, based in large part on a person’s political opinions and leanings, Kowalewski is a passionate advocate for the program and the benefits he believes it brings to his community.

The funds target a portion of the city considered in the greatest need of affordable new housing, an area bounded by the Detroit River, Eureka Road, 15th Street and Ford Avenue.

The city has hired local people to work on the project, such as Jay Sarnacki of Sarnacki & Associates Inc. of Wyandotte, and Santina Daly, a Grosse Ile resident who is marketing the renovated and newly constructed houses and condominium units.

It’s also providing work for construction companies, such as Pizzo Development of Lincoln Park, whose company has been hired to work on some of the houses currently under construction or rehabilitation.

In addition to using geothermal energy, the project is environmentally friendly in another way. Sarnacki pointed out the advance framing technique used in a new-construction house ready to hit the market in a few weeks.

“It’s an old technology that has proven to be more efficient,” Sarnacki said. “It uses 20 percent less lumber (than conventional building techniques).”

Daly said the project has merit from the standpoint of what it does for the city and neighborhood: It puts a property back on the tax rolls and cleans up blight.

But perhaps most importantly, Kowalewski said, is the fact that the program helps put people who otherwise might not be able to afford it into high-quality houses.

Prospective buyers must complete at least eight hours of counseling from a U.S. Department of Housing and Urban Development-certified home counseling agency, which in this case is Lighthouse of Oakland County.

After being prequalified for a mortgage, the purchaser is eligible to buy a house at a price that is less than either the total development costs or the appraised market value.

Kowalewski said that with the Cedar house, the $100,000 appraised value was less than construction costs of about $200,000, so the listing price is the lower of the two.

After it’s determined how much a buyer can afford, a family can receive assistance through a subsidy, which is listed as a no-interest lien. The lien amount dissolves a certain percentage for each year the buyer lives in the house.

Miller said that because the minimum subsidy is 17.5 percent, that translates into $17,500 for the $100,000 house. He said the maximum subsidy is $40,000, even if the house’s listing price would be higher, such as $150,000.

If the buyer moves out before the dissolving of the lien, the amount that remains must be paid to the Michigan State Housing Development Authority at the time of closing.

To make the process fair, all qualified buyers have their names placed in a lottery, which takes place Nov. 14 for the Cedar house.

In the unlikely event no one qualifies to buy the house at the $100,000 list price, Miller said the price would be lowered. Those whose names were not drawn can try their luck at another NSP2 house.

Those who believe they are qualified to purchase this or other NSP2 houses can pick up an application from the Engineering Department at City Hall, 3131 Biddle Ave. A completed application must include required documentation in order to be considered.

Contact Staff Writer Jim Kasuba at **jimk@heritage.com**.

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213 Cedar St
Wyandotte, MI 48192-4622

$100,000
MLS ID: 211102821

WYANDOTTE NSP2 HOME! INCOME GUIDELINES APPLY. BUYERS TO COMPLETE COUNSELING CLASS. SEE ATTACHED APPLICATION & REQUIREMENTS. DOWNPAYMENT ASSISTANCE AVAILABLE. COMPLETELY REMODELED. ENERGY EFFICIENT. GEO THERMAL HEATING AND COOLING. ALL APPLIANCES INCLUDED. ALLEY TO BE PAVED. OPEN HOUSES 10/2 & 10/16 10A-6P

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Office: 313-886-5040
Fax: 313-886-5042
E-mail: grossepointe@tcagents.co

Property Details

MLS ID:	211102821
Style:	Colonial
Year Built:	1908
Bedrooms:	3
Bathrooms:	2 (Full: 2 3/4: 0 1/2: 0 Other: 0)
Status:	Active
Stories:	2
Parking Type Description:	Detached 2 cars
New Construction:	No
Special Considerations:	HUD Foreclosure

Sq. Footage

Total Square Footage:	1,453 ($68.82 per sq. foot)

Features

Appliances

Dishwasher
Disposal
Dryer
Microwave
Refrigerator
Stove
Washer

Architecture

2 Story

Area

05147-WYANDOTTE

Basement

Yes

Bath Description

Lot Information

Lot Size:	50 X 105

Financial Considerations

Tax / Property ID:	A81E76021FC545

Locale

County:	Way
School District:	Wyandotte
Subdivision:	Grand Cross Sub

Rooms

Room	Location	Dimensions
Bedroom 2	Upper Level	13x11
Bedroom 3	Upper Level	11x08
Dining Room	Main Level	11x11
Kitchen	Main Level	13x12
Living Room	Main Level	15x13
Master Bedroom	Upper Level	13x13

1ST FL BTH | 2ND FL BTH

Exterior

VINYL

Exterior Features

PORCH

Foundation

BASEMENT

Fuel Type

GEO-THERMAL

Garage

Yes

Garage Features

DETACHED | ELECT
OPENER

Garage Size

2 CAR

Heating

Y

Homestead

Yes

Other

Directions - Northline To 3rd South To Cedar | Directions E-W -
Directions N-S - Northline | East/West - W
North/South - S | Parcel Number - 5701203001100
Possession - Immediat | Price Per Sqft -
Property ID - A81e76021fc545 | Protection Perio
Square Feet Measurement Src - 1453

Ownership

GOVERNMENT - OWNED

Road Frontage

PAVED

Style

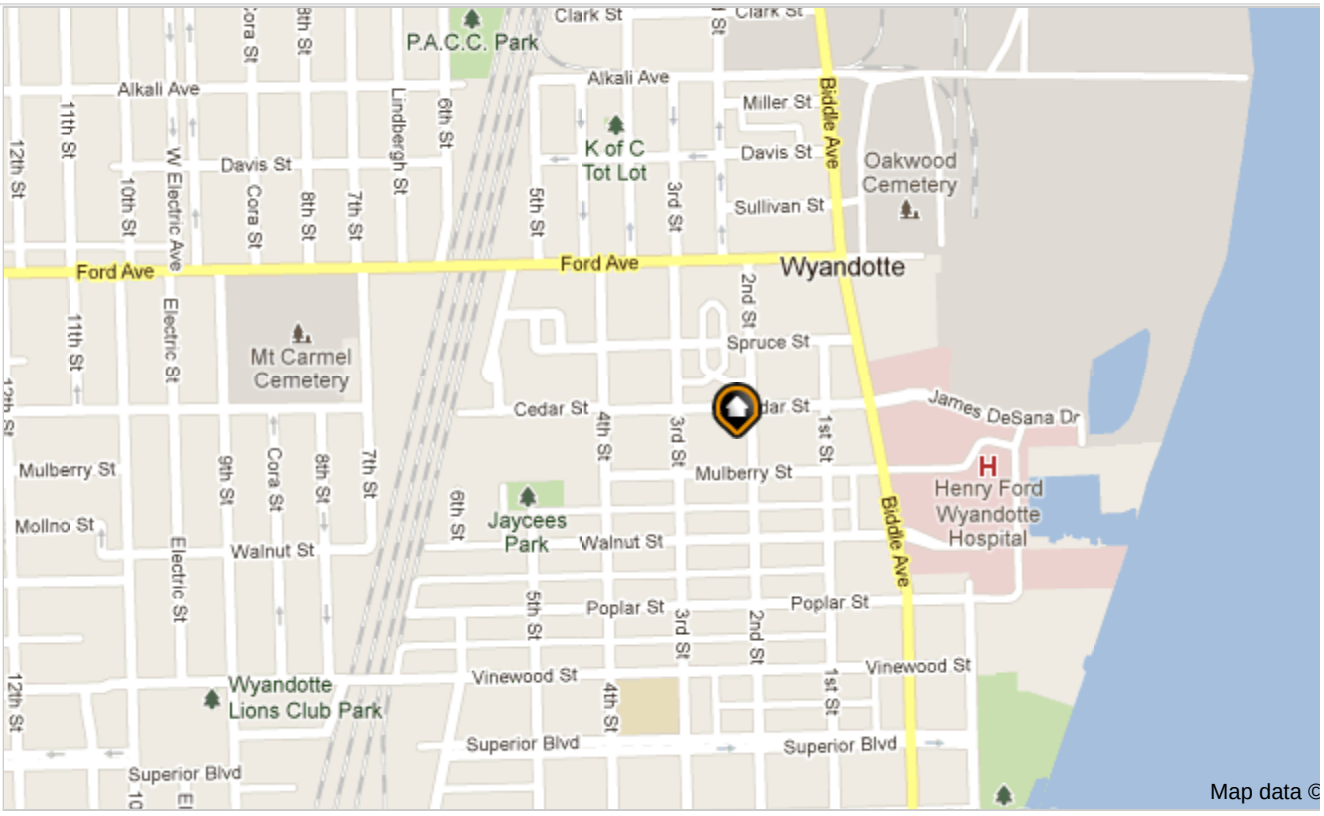
COLONIAL

Terms

FHA

Water/sewer

MUNICIPAL WATER | SEW-SANIT



Listing Courtesy of Jerald Miller of Downriver Real Estate Group

Broker Reciprocity provided courtesy of CENTURY 21 Town & Country
Property Information Last Updated: 10/13/2011 at 2:15 PM.

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Team Contact Information

Table 13. Industry Team Member Contact Information

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Sarnacki & Associates Architects	Dan Boggs	dboggs@sarnackiaia.com	(734) 282-3900
Hardin Geothermal	Dave Congdon	dcongdon@hardingeo.com	(734) 890-1889
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DOE/GO-102013-3607 ▪ April 2013