Chapter 7 – Mitigation Measures

Chapter 7 MITIGATION MEASURES

Many of the potential impacts identified in Chapter 6 are mitigated by existing regulatory programs, both within and outside of DEC. These are identified and described in this chapter, along with recommendations for enhanced procedures and permit conditions necessitated by the unique aspects of horizontal drilling and high-volume hydraulic fracturing. In addition, the proposed EAF Addendum contains a series of informational requirements, such as the disclosure of additives, the proposed volume of fluids used for fracturing, the percentage weight of water, proppants and each additive, and mandatory pre-drilling plans, that also serve as mitigation measures. As with Chapter 6, this Supplement text is not exhaustive with respect to mitigation measures because it incorporates by reference the entire 1992 GEIS and Findings Statement. This document focuses on:

1) mitigation of impacts not addressed by the GEIS (e.g., water withdrawal) and

2) enhancements to GEIS mitigation measures to target potential impacts associated with horizontal drilling, multi-well pad development and high-volume hydraulic fracturing.

Although every single mitigation measure provided by the GEIS is not reiterated herein, such measures remain available and applicable as warranted.

7.1 Protecting Water Resources

The Department is authorized by statute to require the drilling, casing, operation, plugging and replugging of wells and reclamation of surrounding land to, among other things, prevent or

remedy "the escape of oil, gas, brine or water out of one stratum into another" and "the pollution of fresh water supplies by oil, gas, salt water or other contaminants."[1]

In addition to its specific authority to regulate well operations to protect the environment, the Department also has broad authority to "[p]romote and coordinate management of water . . . resources to assure their protection, enhancement, provision, allocation and balanced utilization . . . and take into account the cumulative impact upon all of such resources in making any determination in connection with any . . . permit . . ."[2]

7.1.1 Water Withdrawal Regulatory and Oversight Programs

Existing jurisdictions and regulatory programs address some concerns regarding the impacts related to water withdrawal that are described in Chapter 6. These programs are summarized below, followed by a discussion of three methodologies for mitigating impacts from surface water withdrawals. These are DRBC's method, SRBC's method and the Natural Flow Regime Method, which is preferred by the Department for purposes of the development of gas reserves as described in this document and will be employed unless and until further regulatory guidance or regulations are formally adopted. Mitigation of cumulative impacts is also addressed.

7.1.1.1 NYSDEC Jurisdictions

Degradation of Water Use

Public Water Supply - New York State currently regulates public drinking water supply ground and surface water withdrawals through the public water supply permit program[3] . The NYSDEC also specifically regulates all significant ground water withdrawals for any purpose. These limited water supply permit programs help to protect and conserve available water supplies.

Other Water Withdrawals - NYSDEC also regulates non-public water supply withdrawals in Long Island counties from wells with pumping capacities in excess of 45 gallons per minute. (ECL 15-1527). All water withdrawals within New York's portion of the great lakes basin of 100,000 gallons per day or more (30 day average) must register with the Department (ECL 15-

[1] ECL §23-0305(8)(d)

[2] ECL §23-0301(1)(b)

[3] *Environmental Conservation Law Article 15 Title 15*

1605). Also, all withdrawals within New York's portion of the Delaware and Susquehanna river basins greater than 100,000 gpd must have the approval of the respective basin commission. Although they may be subject to the reporting and registration requirements described below, surface and ground water withdrawals that are not on Long Island and not for drinking water supply currently are unregulated unless the withdrawals occur within the lands regulated by the DRBC and the SRBC. Surface water withdrawals are subject to the recently enacted narrative water quality standard for flow promulgated at 6 NYCRR 703.2. This water quality standard generally prohibits any alteration in flow that would impair a fresh surface waterbody's designated best use.[1] Determination of an appropriate passby flow needs to be done on a case by case basis. However, the TOGS that is necessary to provide effective guidance on the application of the narrative water quality for flow has not been promulgated. For the purpose of this SGEIS only, the Department intends to employ the Natural Flow Regime Method as an interim protection measure in lieu of the flow standard pending completion of the flow standard TOGS.

Water Withdrawal Reporting - Recently passed legislation[4] requires any entity that withdraws, or that has the capacity to withdraw, ground water or surface water in quantities greater than 100,000 gallons per day to file an annual report with the NYSDEC. Inter-basin diversions must be reported on the same form.

Great Lakes Basin Registration - With the exception of water withdrawals subject to ECL Article 15, Title 15 Public Water Supply permits, any existing withdrawal of surface or ground water from the Great Lakes Basin of more than 100,000 gallons per day averaged over a 30 day period must be registered with the Department's Division of Water.

Reduced Stream Flow

The NYSDEC primarily addresses the withdrawal of water and its potential impacts in the following regulations:

- 6 NYCRR 601: Water Supply
- 6 NYCRR 675: Great Lakes Withdrawal Registration Regulations

[4] *ECL Article 15, Title 33*

The requirements of 6 NYCRR 601 pertain to public water supply withdrawals and include an application that describes the project (map, engineer's report and project justification) and the proposed water withdrawal. The applicant is required to identify the source of water, projected withdrawal amounts and detailed information on rainfall and streamflow.

The purpose of 6 NYCRR 675 is to establish requirements for the registration of water withdrawals and reporting of water losses in the Great Lakes Basin. Part 675 is applicable because a portion of the shales considered for potential high-volume fracturing are located within the Great Lakes Basin. Registration is required for non-agricultural purposes in excess of 100,000 gallons per day (30 day consecutive period). An application for withdrawal in the Great Lakes basin is required and addresses location and source of withdrawal, return flow, water usage description, annual and monthly volumes of withdrawal, water loss and a list of other regulatory (federal, state and local) requirements. There are also additional requirements for inter-basin surface water diversions.

Impacts to Aquatic Ecosystems

With respect to disturbances of surface water bodies such as rivers and streams, equipment or structures such as standpipes may require permits under Article 15 of the ECL. The NYSDEC has authority to control the use and protection of the waters of New York State through 6NYCRR, Part 608, Use and Protection of Waters. This regulation enables the agency to control any change, modification or disturbance to a "protected stream", which includes all navigable streams and any stream or portion of a stream with a classification or standard of AA, AA(t), A, A(t), B, B(t) or C(t), and "navigable waters". 6 NYCRR Part 608 regulates the use and protection of waters in the state, and has subparts that address the protection of fish and wildlife species. Under Part 608.2, "No person or local public corporation may change, modify or disturb any protected stream, its bed or banks, nor remove from its bed or banks sand, gravel or other material, without a permit issued pursuant to this Part". The Department reviews permits for changes, modifications, or disturbances to streams with respect to potential environmental impacts on aquatic, wetland and terrestrial habitats; unique and significant habitats; rare, threatened and endangered species habitats; water quality; hydrology; and water course and waterbody integrity. Part 608 does not regulate disturbances of the many streams classified as "C" or below.

Impacts to Wetlands

Actions located within 100 feet of wetlands regulated by Article 24 of the ECL generally require a permit from DEC. Thus, the placement of a structure to withdraw surface water or to withdraw groundwater within 100 feet of the wetland requires a permit. Permits for these structures can only be granted if there is no alternative to placement within 100 feet. If there is no alternative location, a permit can only be granted if the structure has no impact on the wetlands or if that impact is outweighed by an economic and social need.

Aquifer Depletion

The concern for aquifer depletion due to increased ground water use in New York currently is being reviewed and addressed by the DEC. The Department's Division of Water's Pump Test Procedures for Water Supply Applications in conjunction with the SRBC's aquifer testing protocol will be used to evaluate proposed groundwater withdrawals for high-volume hydraulic fracturing.

7.1.1.2 Other Jurisdictions - Great Lakes-St. Lawrence River Water Resources Compact

The recently enacted Great Lakes-St. Lawrence River Water Resources Compact prohibits the bulk transport of water from that basin in containers larger than 5.7 gallons.[1] In addition, effective December 8, 2008, the Great Lakes-St. Lawrence River Basin Water Resources Compact ("Compact")[5] prohibits any new or increased diversion of any amount of water out of the Great Lakes Basin with certain limited exceptions. Also under the Compact, any proposed new or increased withdrawal of surface or groundwater that will result in a consumptive use of 5 million gallons per day or greater averaged over a 90-day period requires prior notice and consultation with the Great Lakes-St. Lawrence River Basin Water Resources Council and the Canadian Provinces of Ontario and Quebec.

Once New York establishes legislation to implement the Compact, all new and increased water withdrawals must comply with the Compact's Decision-Making Standard, Section 4.11, which establishes five criteria all water withdrawal proposals must meet, including:

1) The return of all water not otherwise consumed to the source watershed;

[5] Title 10 of ECL Article 21

2) No significant adverse individual or cumulative impacts shall to the quantity of the waters and water-dependent natural resources;

3) Implementation of environmentally sound and economically feasible water conservation measures shall be implemented;

4) Compliance with all other applicable federal, state, and local laws as well as international agreements and treaties; and

5) Reasonable proposed use of water.

However, until New York establishes implementing legislation and regulations under the Compact, existing requirements for the registration of major withdrawals and diversion approval remain in effect under ECL Article 15, Title 16.

The Great Lakes Commission does not have regulatory authority similar to that held by Susquehanna River Basin Commission (SRBC) and Delaware River Basin Commission (DRBC) to review water withdrawals and uses and require mitigation of environmental impacts. However, the new Great Lakes-St. Lawrence River Water Resources Council has specific authority for the review and/or approval of certain new and increased water withdrawals. Review by the Compact Council will require compliance with the Compact's Decision-Making Standard and Standard for Exceptions.

7.1.1.3 Other Jurisdictions - River Basin Commissions

The Susquehanna River Basin Commission (SRBC) and the Delaware River Basin Commission (DRBC) are interstate compact entities with authority over certain water uses within discrete portions of the State. New York is a member of the Board of these river basin commissions. Those commissions with regulatory programs which address water withdrawals are described below, and mitigation measures provided by those programs are incorporated into subsequent sections.

Table 7.1 is a summary of relevant regulations for each of the governmental bodies with jurisdiction over issues related to water withdrawals. Surface water withdrawals in excess of 100,000 gpd require the approval of the SRBC and DRBC within their respective river basins. In response to increased gas drilling in Pennsylvania, SRBC has recently amended its regulations to

further address gas drilling withdrawals and consumptive use. In addition to surface water withdrawals, SRBC and DRBC control diversions of water into and out of their respective basins. While ECL 15-1505 prohibits transport of water out of New York State via pipes, canals or streams without a permit from the Department, it does not specifically prohibit such transport by tanker truck. Neither SRBC nor DRBC control transfers of water from state-to-state within their basins.

Delaware River Basin Commission Jurisdictions

Degradation of a Stream's Use - Section 3.8 of the DRBC's Compact states "No project having a substantial effect on the water resources of the basin shall hereafter be undertaken by any person, corporation or governmental authority unless it shall have been first submitted to and approved by the Commission, subject to the provisions of Sections 3.3 and 3.5. The Commission shall approve a project whenever it finds and determines that such project would not substantially impair or conflict with the Comprehensive Plan and may modify and approve as modified, or may disapprove any such project whenever it finds and determines that the project would substantially impair or conflict with such Plan". DRBC regulations work collectively to protect Delaware River Basin streams from sources of degradation that would affect the best

Table 7.1 - Regulations Pertaining to Watershed Withdrawal

Agency	Potential Impacts of Reduced Stream Flow	Denigration of Stream's Designated Best Use	Potential Impacts to Downstream Wetlands	Potential Impacts to Fish and Wildlife	Potential Aquifer Depletion
DRBC	Water Code §2.50.2.A Water Code §2.1.1 Water Code §2.5	Water Code, 18 CFR §410 DRBC Compact	Water Code §2.350	Water Code §2.1.1 Water Code §2.200.1 Water Code §3.10.2.B Water Code §3.10.3.A.2 Water Code §3.10.3.A.2.e Water Code §3.30.4.A.1 Water Code §2.1.2 Water Code §3.10.3.A.2.b Water Code 3.20 Water Code 3.30 Water Code 3.40 Water Code 3.30.4.A.1	Water Code §2.50.2.A Water Code §2.20
NYSDEC	6 NYCRR §675 6 NYCRR §605 6 NYCRR §666	6 NYCRR §608 6NYCRR §666	6 NYCRR §663 6 NYCRR §664 6 NYCRR §665	6 NYCRR §595 6 NYCRR §608 6NYCRR §666	Env. Conservation Law §15-15 Env. Conservation Law §15-1528 6 NYCRR §666
SRBC	Reg. of Projects §806.30 Reg. of Projects §801.3 Reg. of Projects §806.23	Reg. of Projects, 18 CFR §801, §806, §807, §808	Reg. of Projects §801.8 Reg. of Projects §806.14	Reg. of Projects §806.23.b.2 Policy 2003_1 Reg. of Projects §801.9 Reg. of Projects §806.14.b.1.v.C	Reg. of Projects §806.23.b.2 Reg. of Projects §806.12 Reg. of Projects §806.22

usage. The DRBC Water Code[6] provides the regulations, requirements, and programs enacted into law that serve to facilitate the protection of these water resources in the Basin.

Reduced Stream Flow - Potential impacts of reduced stream flow associated with shale gas development by high-volume hydraulic fracturing in the Delaware River Basin are under the purview of the DRBC. The DRBC has the authority to regulate and manage surface and ground water quantity-related issues throughout the Delaware River Basin. The DRBC requires that all gas well development operators complete an application for water use that will be subject to Commission review. The DRBC primarily uses the following regulations, procedures and programs to address potential impacts of reduced stream flow associated with a water taking:

- Allocation of water resources, including three major reservoirs for the New York City Water supply;
- Reservoir release targets to maintain minimum flows of surface water;
- Drought management including water restrictions on use, and prioritizing water use;
- Water conservation program;
- Passby flow requirements;
- Monitoring and reporting requirements;
- Aquifer testing protocol.

Impacts to Aquatic Ecosystems - DRBC regulations concerning the protection of fish and wildlife are located in the Delaware River Basin Water Code [7]. In general, DRBC regulations require that the quality of waters in the Delaware basin be maintained "in a safe and satisfactory condition…for wildlife, fish, and other aquatic life" (DRBC Water Code, Article 2.200.1).

One of the primary goals of the DRBC is basin-wide water conservation, which is important for the sustainability of aquatic species and wildlife. Article 2.1.1 of the Water Code provides the basis for water conservation throughout the basin. Under Section A of this Article, water

[6] 18 CFR Part 410

[7] 18 CFR Part 410

conservation methods will be applied to, "reduce the likelihood of severe low stream flows that can adversely affect fish and wildlife resources." Article 2.1.2 outlines general requirements for achieving this goal, such as increased efficiency and use of improved technologies or practices.

All surface waters in the Delaware Basin are subject to the water quality standards outlined in the Water Code. The quality of Basin waters, except intermittent streams, is required by Article 3.10.2B to be maintained in a safe and satisfactory condition for wildlife, fish and other aquatic life. Certain bodies of water in the Basin are classified as Special Protection Waters (also referred to as Outstanding Basin Waters and Significant Resource Waters) and are subject to more stringent water quality regulations. Article 3.10.3.A.2 defines Special Protection Waters as having especially high scenic, recreational, ecological, and/or water supply values. Per Article 3.10.3.A.2.b, no measureable change to existing water quality is permitted at these locations. Under certain circumstances wastewater may be discharged to Special Protection Areas within the watershed; however, it is discouraged and subject to review and approval by the Commission. These discharges are required to have a national pollutant discharge elimination system (NPDES) permit. Non-point source pollution within the Basin that discharges into Special Protection Areas must submit for approval a Non-Point Source Pollution Control Plan.[8]

Interstate streams (tidal and non-tidal) and groundwater (basin wide) water quality parameters are specifically regulated under the DRBC Water Code Articles 3.20, 3.30, and 3.40, respectively. Interstate non-tidal streams are required to be maintained in a safe and satisfactory condition for the maintenance and propagation of resident game fish and other aquatic life, maintenance and propagation of trout, spawning and nursery habitat for anadromous fish, and wildlife. Interstate tidal streams are required to be maintained in a safe and satisfactory condition for the maintenance and propagation of resident fish and other aquatic life, passage of anadromous fish, and wildlife. Groundwater is required to be maintained in a safe and satisfactory condition for use as a source of surface water suitable for wildlife, fish and other aquatic life. It shall be "free from substances or properties in concentrations or combinations

[8] DRBC Water Code, Article 3.10.3.A.2.e

which are toxic or harmful to human, animal, plant, or aquatic life, or that produce color, taste, or odor of the waters."[9]

Impacts to Wetlands - DRBC regulations concerning potential impacts to downstream wetlands are located in the Delaware River Basin Water Code[10] addressed under Article 2.350, Wetlands Protection. It is the policy of the DRBC to support the preservation and protection of wetlands by:

1) Minimizing adverse alterations in the quantity and quality of the underlying soils and natural flow of waters that nourish wetlands;

2) Safeguarding against adverse draining, dredging or filling practices, liquid or solid waste management practices, and siltation;

3) Preventing the excessive addition of pesticides, salts or toxic materials arising from non-point source wastes; and

4) Preventing destructive construction activities generally.

Item 1 directly addresses wetlands downstream of a proposed water withdrawal.

The DRBC reviews projects affecting 25 acres or more of wetlands[11] . Projects affecting less than 25 acres are reviewed by the DRBC only if no state or federal review and permit system is in place, and the project is determined to be of major significance by the DRBC. Additionally, the DRBC will review state or federal actions that may not adequately reflect the Commission's policy for wetlands in the basin.

Aquifer Depletion - DRBC regulations concerning the mitigation of potential aquifer depletion are located in the Delaware River Basin Water Code (18 CFR Part 410). The protection of underground water is covered under Section 2.20 of the DRBC Water Code. Under Section 2.20.2, "The underground water-bearing formations of the Basin, their waters, storage capacity, recharge areas, and ability to convey water shall be preserved and protected". Projects that withdraw underground waters must be planned and operated in a manner which will reasonably

[9] DRBC Water Code, Article 3.30.4.A.1

[10] 18 CFR 410

[11] DRBC Water Code, Article2.350.4

safeguard the present and future groundwater resources of the Basin. Groundwater withdrawals from the Basin must not exceed sustainable limits. No groundwater withdrawals may cause an aquifer system's supplies to become unreliable, or cause a progressive lowering of groundwater levels, water quality degradation, permanent loss of storage capacity, or substantial impact on low flows or perennial streams (DRBC Water Code, Article 2.20.4) Additionally, "The principal natural recharge areas through which the underground waters of the Basin are replenished shall be protected from unreasonable interference with their recharge function" (DRBC Water Code, Article 2.20.5).

The interference, impairment, penetration, or artificial recharge of groundwater resources in the basin are subject to review and evaluation by the DRBC. All owners of individual wells or groups of wells that withdraw an average of 10,000 gallons per day or more during any 30-day period from the underground waters of the Basin must register their wells with the designated agency of the state where the well is located. Registration may be filed by the agents of owners, including well drillers. Any well that is replaced or re-drilled, or is modified to increase the withdrawal capacity of the well, must be registered with the designated state agency (Delaware Department of Natural Resources and Environmental Control; New Jersey Department of Environmental Protection; New York State Department of Environmental Conservation; or the Pennsylvania Department of Environmental Protection) (DRBC Water Code, Article 2.20.7).

Groundwater withdrawals from aquifers in the Basin that exceed 100,000 gallons per day during any 30-day period are required be metered, recorded, and reported to the designated state agencies. Withdrawals are to be measured by means of an automatic continuous recording device, flow meter, or other method, and must be measured to within five percent of actual flow. Withdrawals must be recorded on a biweekly basis and reported as monthly totals annually. More frequent recording or reporting may be required by the designated agency or the DRBC (DRBC Water Code, 2.50.2.A).

Susquehanna River Basin Commission Jurisdictions

Degradation of a Stream's Use - The SRBC has been granted statutory authority to regulate the conservation, utilization, development, management, and control of water and related natural resources of the Susquehanna River Basin and the activities within the basin that potentially

affect those resources. The SRBC controls allocations, diversions, withdrawals, and releases of water in the basin to maintain the appropriate quantity of water. The SRBC Regulation of Projects[12] provides the details of the programs and requirements that are in effect to achieve the goals of the commission.

Reduced Stream Flow - The SRBC has the authority to regulate and manage surface and ground water withdrawals and consumptive use in the Susquehanna River Basin. The SRBC requires that all gas well development operators complete an application for water use that will be subject to Commission review. The SRBC primarily uses the following regulations, procedures and programs to address potential impacts of reduced stream flow associated with a water taking:

- Consumptive use regulations;
- Mitigation measures;
- Conservation measures and water use alternatives;
- Conservation releases;
- Evaluation of safe yield (7-day, 10-year low flow);
- Passby requirements;
- Monitoring and reporting requirements;
- Aquifer testing protocol.

Impacts to Aquatic Ecosystems -SRBC regulations concerning the protection of fish and wildlife are located in the Susquehanna River Basin Commission Regulation of Projects [13]. In general, the Commission promotes sound practices of watershed management for the purposes of improving fish and wildlife habitat (SRBC Regulation of Projects, Article 801.9).

Projects requiring review and approval of the SRBC under §§ 806.4, 806.5, or 806.6 are required to submit to the Commission a water withdrawal application. Applications are required to contain the anticipated impact of the proposed project on fish and wildlife (SRBC Regulation of

[12] 18CFR, Parts 801, 806, 807, and 808

[13] 18 CFR Parts 801, 806, 807, and 808

Projects, Article 806.14.b.1.v.C). "The Commission may deny an application, limit or condition an approval to ensure that the withdrawal will not cause significant adverse impacts to the water resources of the basin."[14] The Commission considers water quality degradation affecting fish, wildlife or other living resources or their habitat to be grounds for application denial.

Water withdrawal from the Susquehanna River Basin is governed by passby flow requirements that can be found in the SRBC Policy Document 2003-1, "Guidelines for Using and Determining Passby Flows and Conservation Releases for Surface-water and Ground-water Withdrawal Approvals." A passby flow is a prescribed quantity of flow that must be allowed to pass a prescribed point downstream from a water supply intake at any time during which a withdrawal is occurring. The methods by which passby flows are determined for use as impact mitigation are described below.

Impacts to Wetlands - Projects requiring review and approval of the SRBC under §§ 806.4, 806.5, or 806.6 are required to submit to the Commission a water withdrawal application. Applications are required to contain the anticipated impact of the proposed project on surface water characteristics, and on threatened or endangered species and their habitats.[15]

Aquifer Depletion - Evaluation of ground water resources includes an aquifer testing protocol to evaluate whether well(s) can provide the desired yield and assess the impacts of pumping. The protocol includes step drawdown testing and a constant rate pumping test. Monitoring requirements of ground water and surface water are described in the protocol and analysis of the test data is required. This analysis typically includes long term yield and drawdown projection and assessment of pumping impacts.

7.1.1.4 Impact Mitigation Measures for Surface Water Withdrawals

Delaware River Basin Commission Method

DRBC has the charge of conserving water throughout the Delaware basin by reducing the likelihood of severe low stream flows that can adversely affect fish and wildlife resources and

[14] SRBC Regulation of Projects, Article 806.23.b.2

[15] SRBC Regulation of Projects, Article 806.14

recreational enjoyment (18 CFR Part 410, section 2.2.1). The DRBC currently has no specific passby regulation or policy. Prescribed reservoir releases play an important role in Delaware River flow. The DRBC uses a Q7-10 flow for water resource evaluation purposes. The Q7-10 flow is the drought flow equal to the lowest mean flow for seven consecutive days, that has a 10-year recurrence interval.

The Q7-10 is a flow statistic developed by sanitary engineers to simulate drought conditions in water quality modeling when evaluating waste load assimilative capacity (e.g., for point sources from waste water treatment plants). Q7-10 is not meant to establish a direct relation between Q7-10 and aquatic life protection.[16] For most streams, the Q7-10 flow is less than 10% of the average annual flow and may result in degradation of aquatic communities if it becomes established as the only flow protected in a stream.[17]

Susquehanna River Basin Commission Method

The SRBC requires that passby flows, prescribed quantities of flow that must be allowed to pass a prescribed downstream point, be provided as mitigation for water withdrawals. This requirement is prescribed in part to conserve fish and wildlife habitats. "Approved surface-water withdrawals from small impoundments, intake dams, continuously flowing springs, or other intake structures in applicable streams will include conditions that require minimum passby flows. Approved ground water withdrawals from wells that, based on an analysis of the 120-day drawdown without recharge, impact streamflow, or for which a reversal of the hydraulic gradient adjacent to a stream (within the course of a 48-hour pumping test) is indicated, also will include conditions that require minimum passby flows."[18] There are three exceptions to the required passby flow rules stated above:

1) If the surface-water withdrawal or groundwater withdrawal impact is minimal in comparison to the natural or continuously augmented flows of a stream or river, no passby flow will be required. Minimal is defined by SRBC as 10

[16] Camp, Dresser and McKee 1986

[17] Tennant 1976a,b

[18] SRBC, Policy 2003-01

percent or less of the natural or continuously augmented 7-day, 10-year low flow (Q7-10) of the stream or river.

2) For projects requiring Commission review and approval for an existing surface-water withdrawal where a passby flow is required, but where a passby flow has historically not been maintained, withdrawals exceeding 10 percent of the Q7-10 low flow will be permitted whenever flows naturally exceed the passby flow requirement plus the taking. Whenever stream flows naturally drop below the passby flow requirement plus the taking, both the quantity and the rate of the withdrawal will be reduced to less than 10 percent of the Q7-10 low flow.

3) If a surface-water withdrawal is made from one or more impoundments (in series) fed by a stream, or if a ground-water withdrawal impacts one or more impoundments fed by a stream, a passby flow, as determined by the criteria discussed below or the natural flow, whichever is less, will be maintained from the most downstream impoundment at all times during which there is inflow into the impoundment or series of impoundments.

In cases where passby flow is required, the following criteria are to be used to determine the appropriate passby flow for SRBC-Classified Exceptional Value (EV) Waters, High Quality (HQ) Waters, and Cold-Water Fishery (CWF) Waters; For EV Waters, withdrawals may not cause greater than five percent loss of habitat. For HQ Waters, withdrawals may not cause greater than five percent loss of habitat as well; however, a habitat loss of 7.5 percent may be allowed if:

1) The project is in compliance with the Commission's water conservation regulations of Section 804.20;

2) No feasible alternative source is available; and

3) Available project sources are used in a program of conjunctive use approved by the Commission, and combined alternative project source yields are inadequate.

For Class B[19], CWF Waters, withdrawals may not cause greater than a 10 percent loss of habitat. For Classes C and D, CWF Waters, withdrawals may not cause greater than a 15 percent loss of habitat. For areas of the Susquehanna River Basin not covered by the above regulations, the following shall apply:

[19] Water classifications referenced in this section are those established by State of PA which are not equivalent to NYS stream classifications

1) On all EV and HQ streams, and those streams with naturally reproducing trout populations, a passby flow of 25 percent of average daily flow will be maintained downstream from the point of withdrawal whenever withdrawals are made.

2) On all streams not covered in Item 1 above and which are not degraded by acid mine drainage, a passby flow of 20 percent of average daily flow will be maintained downstream from the point of withdrawal whenever withdrawals are made. These streams generally include both trout stocking and warm-water fishery uses.

3) On all streams partially impaired by acid mine drainage, but in which some aquatic life exists, a passby flow of 15 percent of ADF will be maintained downstream from the point of withdrawal whenever withdrawals are made.

4) Under no conditions shall the passby flow be less than the Q7-10 flow.

Natural Flow Regime Method

The "Natural Flow Regime Method" is an alternative to the DRBC and SRBC methods and establishes a passby flow designed to avoid significant adverse environmental impacts from withdrawals for high-volume hydraulic fracturing; specifically impacts associated with: degradation of a stream's best use and reduced stream flow including impacts to aquatic habitat and aquatic ecosystems.

To assure adequate surface water flow, water withdrawals must provide for a passby flow in the stream, as defined above. In general, when streamflow data exist for the proposed withdrawal location, the passby flow is calculated for each month of the year using a combination of 30% of Average Daily Flows (ADF), and 30% of Average Monthly Flows, (AMF). For any given month, the minimum passby flow must be the greater of either the 30% ADF **or** 30% AMF flow.

The purpose of the "Natural Flow Regime Method" is to provide seasonally adjusted instream flows that maintain the natural formative processes of the stream while requiring only minimal to moderate effort to calculate. Once adequate streamflow records are obtained, ADF is easily calculated. The foundation of the "Natural Flow Regime Method" is based on work of Tennant[20] using percentages of average daily flow (ADF) derived from estimated or recorded hydrologic records, limited field measurements, and photographs taken at multiple discharges. The basic

[20] Tennant 1972, 1975, 1976a,b

assumption of the method is that varying flows based on percentages of ADF or AMF are appropriate for maintaining differing levels of habitat quality within the stream and that the time periods for providing different levels of flow are appropriate based on life stage needs of the aquatic biota. Natural hydrologic variability is used as a surrogate for biological, habitat, and use parameters including: depth, width, velocity, substrate, side channels, bars and islands, cover, migration, temperature, invertebrates, fishing and floating, and aesthetics.

The "Natural Flow Regime Method" approach to passby flow is to retain naturalized annual stream flow patterns (hydrographs) and otherwise, avoid non-naturalized flows that may degrade stream conditions and result in adverse impacts.[21] Tennant never intended users to select only one flow throughout the year (e.g., 20% ADF) because using a single flow would not reflect seasonal patterns in hydrology. Tessmann[22] and others [23] adapted Tennant's seasonal flow recommendations to calibrate the percentages of ADF to local hydrologic and biologic conditions including monthly variability based on average monthly flow (AMF).

The "Natural Flow Regime Method" described here has adopted and refined these recommendations to provide for different flows on a monthly basis. The result is that passby flows calculated under this method follow the natural hydrograph, including flushing flows that define and maintain the stream habitat suitable for aquatic biota. Research by Estes[24] and Reiser et al.[25] supports the need for these channel-maintaining flows.

There are certain limitations associated with the "Natural Flow Regime Method" that must be considered, as it assumes a relationship to the stream biology. Data on historic stream flows must be of a sufficient duration and quality to represent the natural flow regimes of the stream[26] as prescriptions for passby flows are only as good as the hydrologic records on which they are based. Beyond concerns over the quality of available hydrologic data, data that are not based on

[21] IFC 2004

[22] Tessmann 1980

[23] Estes 1984, 1998

[24] Estes 1984

[25] Reiser et al. 1988

[26] Estes 1998

natural flow conditions (e.g., releases from dams) will influence the calculation of pass by flows and may not support fishery management objectives.

The following considerations regarding the quality of the streamflow data to be used for a proposed water withdrawal location should be applied for each withdrawal (also see Table 7.1 below):

- If the proposed water withdrawal site is in close proximity to an existing USGS gauge location, with at least 10 recent years of continuous daily flow monitoring data, regardless of drainage basin size, then the passby flow can be calculated which incorporates the appropriate ADF and AMF values.

- If the proposed water withdrawal site is within the same drainage as a USGS gauge location possessing 10 recent years or more of continuous daily flow monitoring data , but sources of inflow exist between the two locations then either of the following criteria apply regardless of drainage basin size:

    - When the gauge is located upstream from the withdrawal location, the gauge data must be appropriately adjusted to account for the percent increase in the drainage area at the withdrawal location. (Example: If the drainage area at gauge is 250 square miles and the drainage area at the withdrawal point is 300 square miles, then the data statistics from the gauge would be multiplied by 1.2 for determining passby flows at the withdrawal site.), OR

    - When the gauge is located downstream from the withdrawal location, the gauge data must be appropriately adjusted to account for the percent decrease in the drainage area at the withdrawal location. (Example: If the drainage area at gauge is 250 square miles and the drainage area at the withdrawal point is 200 square miles, then the data statistics from the gauge would be multiplied by 0.8 for determining passby flows at the withdrawal site.)

- If the proposed water withdrawal site is located in a drainage that does not possess a USGS source of streamflow data, then streamflow data can be developed from surrogate streams that have USGS gauging. Surrogate streams should have similar drainage characteristics to the stream where the withdrawal is proposed.

- If the proposed water withdrawal site is located in a drainage basin that is not capable of being represented by a surrogate stream that possesses USGS streamflow data, then the passby flow shall be determined as follows:

  The Aquatic Base Flow method should be used where the passby flow is based on the drainage basin size where:

- from June 1 through October 31, 0.5 cfs/mi^2 of drainage area should be provided, and
- from November 1 through May 31, 1.0 cfs/mi^2 of drainage area should be provided.

For trout waters (i.e protected streams possessing a NY State water quality classification or standard with a (t) or (ts) designation), 4.0 cfs/mi^2 of drainage area during the spring (March 1 through May 31) should be provided. As a general rule, streams having a drainage area of less than 100 square miles may not have suitable surrogates available from which to obtain appropriate streamflow data.

Table 7.2 - Methods for Determination of Passby Flow Based on Data Availability

Data Availability	**Method for Determination of Passby Flow**	
For locations where at least 10 recent years of gauging data are available	A passby flow shall be calculated for each month of the year using a combination of 30% of Average Daily Flows (ADF), and 30% of Average Monthly Flows, (AMF). For any given month the proposed passby flow must be the greater of either the 30% ADF or 30% AMF Flow.	
For locations where less than 10 recent years of gauging data are available	0.5 cfs/mi^2 of drainage area during summer	1.0 cfs/mi^2 of drainage area during winter
In addition, for locations known to support trout, where less than 10 recent years of gauging data are available	4.0 cfs/mi^2 of drainage area during the spring (March 1 through May 31)	

7.1.1.5 Cumulative Water Withdrawal Impacts

The SRBC (February, 2009) stated that "the cumulative impact of consumptive use by this new activity (natural gas development), while significant, appears to be manageable with the

mitigation standards currently in place." The extent of the gas-producing shales in New York extends beyond the jurisdictional boundaries of the SRBC and the DRBC. The potential exists for gas drilling and associated water withdrawal to occur outside of the Susquehanna and Delaware River Basins. New York State regulations do not address water quantity issues in a manner consistent with those applicable within the Susquehanna and Delaware River Basins with respect to controlling, evaluating, and monitoring surface water and ground water withdrawals for shale gas development. The application of the Natural Flow Regime Method to all surface water withdrawals to support the subject hydraulic fracturing operations is an option to comprehensively address cumulative impacts on stream flows. Adverse cumulative impacts could be addressed by the Natural Flow Regime Method described above if each operator of a permitted surface water withdrawal estimated or reported the maximum withdrawal rate and measured the actual passby flow for any period of withdrawal. This is because the stream gauge measurements which govern the pass by flow calculation reflect the natural hydrograph of an unregulated stream and do not take into account pre-existing or upstream withdrawals.

7.1.2 Stormwater

The principal control mechanism to mitigate negative impacts from stormwater runoff is to develop, implement and maintain comprehensive Stormwater Pollution Prevention Plans (SWPPP). These plans address the often significant impacts of erosion, sedimentation, peak flow increase, contaminate discharge and nutrient pollution that is associated with industrial activity, including construction projects. Such concerns are raised with the excavation necessary to support the access roads, drill pads, impoundments, staging areas, and pipeline routes associated with the subject operations. This is commonly conducted through the administration of the NYSDEC general permits for stormwater runoff, which require operators to develop, implement and maintain up-to-date SWPPPs. To assist this effort, the NYSDEC has produced technical criteria for the planning, construction, operation and maintenance of stormwater control practices and procedures, including temporary, permanent, structural and non-structural measures. Copies of the general permits and technical guidance can be found on the NYSDEC website at http://www.dec.ny.gov/chemical/8468.html. These controls are Clean Water Act permits required pursuant to the Act and underlying EPA regulations.

A successful SWPPP employs fairly simple concepts aimed at preventing erosion and maintaining post-development runoff characteristics in roughly the same manner as the pre-development condition. Many adverse impacts may be avoided by planning a development to fit site characteristics, like avoiding steep slopes and maintaining sufficient separation from environmentally sensitive features, such as streams and wetlands. Another basic principal is to divert uncontaminated water away from excavated or disturbed areas. In addition, limiting the amount of exposed soil at any one time, stabilizing disturbed areas with mulch and seed as soon as possible, and following equipment maintenance, rapid spill cleanup and other basic good housekeeping measures will act to minimize potential impacts. Lastly, measures to treat stormwater and control runoff rates are used.

A comprehensive SWPPP that is well developed, implemented, maintained and adapted to changing circumstances in strict compliance with the DEC general permit and associated technical standards should effectively act to heighten the beneficial aspects of stormwater runoff while minimizing its potential deleterious impacts.

The Department has determined that natural gas well development using high-volume hydraulic fracturing is eligible for inclusion in Sector AD of the Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (GP-0-06-002) (MGSP).[27] The Department is proposing the option of amending this Multi-Sector General Permit to address a number of potential pollutant discharges associated with the subject operations. As discussed below, the Department is proposing a method to terminate the application of the MSGP after completion of major operations.

7.1.2.1 Construction Activities

In order to facilitate the permitting process for activities addressed by this Supplement, the requirements associated with the General Permit for Stormwater Discharges Associated with Construction Activities (Construction General Permit) will be incorporated into Sector AD of the MGSP as it applies to the subject operation.

[27] http://www.dec.ny.gov/chemical/9009.html

A SWPPP, meeting or exceeding the requirements of the Construction General Permit, must be developed as a stand-alone document and incorporated, by reference, in a comprehensive SWPPP. The SWPPP will address all phases and elements of the activity, including all land clearing and access road, well pad and impoundment construction and apply during all hydraulic fracturing and flowback operations at a well pad. SWPPPs shall be prepared in accordance with good engineering practices and DEC's General Permit for Construction Activity.

Inspections and documentation of inspections must be initiated upon commencement of construction activities and continue until coverage under the MSGP has been appropriately terminated.

7.1.2.2 Industrial Activities

The MSGP will be revised as necessary to incorporate a required SWPPP for industrial activities to address potential sources of pollution which may reasonably be expected to affect the quality of stormwater discharges associated with industrial activity from Marcellus Shale and other low-permeability gas reservoir hydraulic fracturing operations. In addition, the comprehensive SWPPP shall describe and ensure the implementation of Best Management Practices (BMPs) which are to be used to reduce the pollutants in stormwater discharges associated with industrial activity at the facility and to ensure compliance with the terms and conditions of the MSGP. Structural, nonstructural and other BMPs must be considered in the SWPPP. Structural BMPs include features such as dikes, swales, diversions, drains, traps, silt fences and vegetative buffers. Nonstructural BMPs include good housekeeping, sheltering activities to minimize exposure to precipitation to the extent practicable, preventative maintenance, spill prevention and response procedures, routine facility inspections, employee training and use of designated vehicle and equipment storage or maintenance areas with adequate stormwater controls. A copy of the SWPPP must be kept on site and available to Department inspectors while permit coverage is in effect.

Monitoring and reporting, in addition to construction related inspections and reports, includes quarterly visual monitoring, an annual dry weather flow inspection, annual site compliance evaluation and annual benchmark monitoring and analysis. Quarterly visual monitoring must commence with construction. Benchmark monitoring must be completed while hydraulic

fracturing operations are being conducted or, if no qualifying storms occurred during hydraulic fracturing operations, during the first qualifying storm event thereafter.[28] Sites active for less than one year must satisfy all annual reporting requirements within the period of activity.

MSGP coverage may be terminated upon completion of all drilling and hydraulic fracturing operations, fracturing flowback operations and partial site reclamation. Partial site reclamation has occurred when the Department determines that drilling and fracturing equipment has been removed, pits used for those operations have been reclaimed and surface disturbances not associated with production activities have been re-graded and seeded, and vegetation cover reestablished, and post-construction management practices are fully operational. Operators may, however, elect to maintain coverage if they so choose. In addition, coverage must be maintained if it is otherwise required under the Clean Water Act.

7.1.3 Surface Spills and Releases at the Well Pad

A combination of existing Department tools, enhanced as necessary to address unique aspects of multi-well pad development and high-volume hydraulic fracturing, will be required in appropriate permits to prevent spills and mitigate adverse impacts from any that do occur. Activities and materials on the well pad of concern with respect to potential surface and groundwater impacts from unmitigated spills and releases include the following:

- drilling rig fuel tank and tank refilling activities,
- drilling fluids,
- hydraulic fracturing additives, and
- flowback water.

The proposed spill prevention and mitigation measures advanced herein reflect consideration of the following information reviewed by Department staff:

- The 1992 GEIS and its Findings;

[28] A qualifying storm is one greater than 0.1 inch in magnitude that occurs at least 72 hours from the previously measurable (>0.1 inch rainfall) storm event.

- GWPC, 2009b:
- Alpha, 2009, regarding:
    - a survey of regulations related to natural gas development activities in Pennsylvania, Colorado, New Mexico, Wyoming , Texas (including the City of Fort Worth), West Virginia, Louisiana, Ohio and Arkansas;
    - materials handling and transport requirements, including USDOT and NYSDOT regulations, NYSDEC Bulk Storage Programs and USEPA reporting requirements; and
    - specific recommendations for minimizing potential liquid chemical spills;
- Guidance documents relative to the Department's Petroleum Bulk Storage Program, including:
    - Spill Prevention Operations Technology Series (SPOTS) 10, Secondary Containment Systems for Aboveground Storage Tanks,[29] and
    - Draft DEC Program Policy DER-17[30];
- SWPPP guidance compiled by the Department's Division of Water;
- US Department of the Interior and US Department of Agriculture, 2007; and
- An industry Best Management Practices (BMP) manual provided to the Department.

7.1.3.1 Drilling Rig Fuel Tank and Tank Refilling Activities

The diesel tank associated with the larger rigs described in Chapter 5 may be larger than 10,000 gallons in capacity and may be in one location on a multi-well pad for the length of time required to drill all of the wells on the pad. However, the tank is removed along with the rig during any drilling hiatus between wells or after all the wells have been drilled. There are no long-term or permanent operations at a drill pad which require an on-site fuel tank. Therefore, the tank is considered non-stationary and is exempt from the Department's petroleum bulk storage regulations and tank registration requirements. The following measures will be implemented to mitigate spills:

[29] http://www.dec.ny.gov/docs/remediation_hudson_pdf/spots10.pdf

[30] http://www.dec.ny.gov/docs/remediation_hudson_pdf/der17.pdf

1) The EAF Addendum will require information regarding the capacity and planned well pad location of rig fuel tanks and distance to any primary or principal aquifer, public or private water well, domestic-supply spring, reservoir, reservoir stem, controlled lake, watercourse, perennial or intermittent stream, storm drain, wetland, lake or pond within 500 feet of the planned tank location. To the extent practical, the Department will encourage operators to position the tank more than 500 feet from these water resources.

2) For multi-well pads, supplementary permit conditions for high-volume hydraulic fracturing will include the following requirements:

    a. Secondary containment consistent with the objectives SPOTS 10 for all tanks larger than 10,000 gallons and for smaller tanks if the tank will be positioned within 500 feet of a primary or principal aquifer, public or private water well, a domestic-supply spring, a reservoir, reservoir stem or controlled lake, watercourse, perennial or intermittent stream, storm drain, wetland, lake or pond.

        The secondary containment system could include one or a combination of the following: dikes, liners, pads, holding ponds, impoundments, curbs, ditches, sumps, receiving tanks or other equipment capable of containing spilled fuel. Soil that is used for secondary containment should be of such character that a spill into the soil will be readily recoverable and will result in a minimal amount of soil contamination and infiltration. Draft DEC Program Policy DER-17[31] may be consulted for permeability criteria for dikes and impoundment floors and dike construction standards, including capacity of at least 110% of the tank's volume.

        Implementation of secondary containment and permeability criteria is consistent with GWPC's recommendations.

    b. Tank filling operations must be manned at the fueling truck and at the tank if the tank is not visible to the fueling operator from the truck.

    c. Troughs, drip pads or drip pans will be required beneath the fill port of the tank during filling operations if the fill port is not within the secondary containment.

3) The comprehensive Stormwater Pollution Prevent Plan (SWPPP) that is required by the Department's Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (GP-0-06-002) (MSGP) will include Best Management Practices to minimize or eliminate pollutants in stormwater. Such BMPs include, but are not limited to, a combination of some or all of the following, or other equally protective practices:

    a. Identification of a spill response team and employee training on proper spill prevention and response techniques,

[31] http://www.dec.ny.gov/docs/remediation_hudson_pdf/der17.pdf

b. Inspection and preventative maintenance protocols for the tank(s) and fueling area,

c. Procedures for notifying appropriate authorities in the event of a spill,

d. Procedures for immediately stopping the source of the spill and containing the liquid until cleanup is complete,

e. Ready availability of appropriate spill containment and clean-up materials and equipment, including oil-containment booms and absorbent material,

f. Disposal of cleanup materials in the same manner as the spilled material,

g. Use of dry cleanup methods and non-use of emulsifiers or dispersants,

h. Protocols for checking/testing stormwater in containment area prior to discharge,

i. Conduct of tank filling operations under a roof or canopy where possible, with the covering extending beyond the spill containment pad to prevent rain from entering,

j. Use of drip pans where leaks or spills could occur during tank filling operations and where making and breaking hose connections,

k. Use of fueling hoses with check valves to prevent hose drainage after spilling,

l. Use of spill and overflow protection devices,

m. Use of diversion dikes, berms, curbing, grading or other equivalent measures to minimize or eliminate run-on into tank filling areas,

n. Use of curbing or posts around the fuel tank to prevent collisions during vehicle ingress and egress, and

o. Availability of a manual shutoff valve on the fueling vehicle.

7.1.3.2 Drilling Fluids

The GEIS describes reserve pits excavated at the well which may contain drill cuttings, drilling fluid, formation water, and flowback water from a single well. As stated in the GEIS:

> Although the existing regulations do mention clay and hardpan as options in pit construction, the Department has consistently required that all earthen temporary drilling pits be lined with sheets of plastic before they can be used. Clay and hardpan are both low in permeability, but they are not watertight. They are also subject to chemical reaction with some drilling and completion fluids. In addition, the time constraints on drilling operations do not allow adequate time for the percolation tests which should be performed to check the permeability of a clay lined pit. Liners for large pits are usually made from several sheets of plastic which should be factory seamed. Careful attention to sealing the seams is extremely important in preventing groundwater contamination; [32]

and:

> Pits for fluids used in the drilling, completion, and re-completion of wells should be constructed, maintained and lined to prevent pollution of surface and subsurface waters and to prevent pit fluids from contacting surface soils or ground water zones. Department field inspectors are of the opinion that adequate maintenance after pit liner installation is more critical to halting pollution than the initial pit liner specifications. Damaged liners must be repaired or replaced promptly. Instead of very detailed requirements in the regulations, the regulatory and enforcement emphasis will be on a general performance standard for initial review of liner-type and on proper liner maintenance.
>
> The type and specifications of the liner proposed by the well drilling applicant will require approval by the DEC Regional Minerals Manager. The acceptability of each proposed pit construction and location should be determined during the pre-site inspection. Any pit site or pit orientation found unacceptable to the Department must be changed as directed by the regional site inspector.[33]

Regulations require that pit fluids must be removed within 45 days of cessation of drilling operations (includes stimulation), "unless the department approves an extension based on circumstances beyond the operator's control. The Department may also approve an extension if the fluid is to be used in subsequent operations according to the submitted plan, and the department has inspected and approved the storage facilities." [34]

[32] p. 9-32

[33] p. FGEIS48

[34] 6 NYCRR 554.(1)(c)(3)

Within primary and principal aquifers, permit conditions require that if operations are suspended and the site is left unattended, pit fluids must be removed from the site immediately.[35] After the cessation of drilling and/or stimulation operations, pit fluids must be removed within seven days.

Recommended GEIS specifications, and the ultimate decision to use a site and performance-based standard rather than detailed specifications, were largely based upon the short duration of a pit's use. Pits used for more than one well will be used for a longer period of time. "The containment of fluids within a pit is the most critical element in the prevention of shallow ground water contamination."[36] Specifications more stringent than those proposed in the GEIS which relate to durability and longer duration of use are appropriate, and are consistent with GWPC's recommendations (Section 5.18.1.2). Additional protection will be provided by the requirement for an SWPPP and by measuring SEQRA setbacks from the edge of the well pad instead of from the well.

The following measures will be implemented to mitigate the potential for releases associated with the on-site reserve pit:

1) The EAF Addendum will require information about the planned location, construction and capacity of the reserve pit. The Department will not approve reserve pits on the filled portion of cut-and-fill sites.

2) Supplementary permit conditions for multi-well pad high-volume hydraulic fracturing will include the following requirements:

    a. Diversion of surface water and stormwater runoff away from the pit,

    b. Pit volume limit of 250,000 gallons, or 500,000 gallons for multiple pits on one tract or related tracts of land,

    c. Beveled walls (45 degrees or less) for pits constructed in unconsolidated materials,

    d. Sidewalls and bottoms free of objects capable of puncturing and ripping the liner,

    e. Sufficient slack in liner to accommodate stretching,

[35] Freshwater Aquifer Supplementary Permit Conditions, www.dec.ny.gov/energy/42714.html

[36] GWPC, 2009a. p. 29

f. Minimum 30-mil liner thickness,

g. Liners installed and seamed in accordance with the manufacturer's specifications,

h. Freeboard monitoring and maintenance of 2 feet of freeboard at all times,

i. Fluids removed and pit inspected prior to additional use if longer than a 45-day gap in use, and

j. Fluids removed and pit reclaimed within 45 days of completing drilling and stimulation operations at last well on pad.

2) The following additional or more stringent requirements will be included in well permit conditions for multi-well pad high-volume hydraulic fracturing in primary or principal aquifers areas or unfiltered water supply areas.

a. Removal of pit fluids within 7 days of drilling/stimulation operations for each well, and inspection by the Department prior to use for the next well;

b. Immediate removal of pit fluids if operations are suspended and the site is left unattended; and

c. Removal of pit fluids within 7 days of completing drilling and stimulation operations at last well on pad.

3) The comprehensive SWPPP that is required by the Department's MSGP (GP-0-06-002) will include Best Management Practices relative to reserve pit fluid containment, including, but not limited to, a combination of some or all of the following, or other equally protective practices:

a. Identification of a spill response team and employee training on proper spill prevention and response techniques,

b. Inspection and preventative maintenance protocols for the pit walls and liner,

c. Procedures for immediately notifying appropriate authorities in the event of a significant pit failure resulting in discharge to ground or surface water,

d. Procedures for immediately repairing the pit or liner and containing the released liquid until cleanup is complete,

e. Ready availability of appropriate spill clean-up materials and equipment,

f. Disposal of cleanup materials in the same manner as the spilled material, and

g. Use of dry cleanup methods, and non-use of emulsifiers or dispersants.

7.1.3.3 Hydraulic Fracturing Additives

Chapter 5 describes the USDOT- or UN-approved containers in which hydraulic fracturing additives are delivered and held until they are mixed with water and proppant and pumped into the well, and also describes the length of time that additives are present on the site. The inherent mitigation factors stated in Section 6.1.11 with respect to the risks presented by high-volume hydraulic fracturing in the New York City Watershed are not unique to that watershed but exist at all locations. Well pad setbacks from water resources described in Section 7.1.12 also apply to all locations. Additional mitigation measures will be implemented as follows:

1) Specific secondary containment requirements will be included in supplementary well permit conditions for high-volume hydraulic fracturing on a site-specific basis if the proposed location or operation raises a concern about potential liquid chemical releases that is not, in the Department's judgment, sufficiently addressed by the GEIS, the SGEIS, inherent mitigation factors and well pad setbacks.

   In this instance, the Department may require the applicant to identify in application materials the anticipated maximum number, type, and volume of liquid fracturing additive containers to be simultaneously present onsite. This is in addition to the fluid disclosure requirements on the EAF Addendum. The Department will evaluate whether those containers could reasonably be anticipated to discharge to surface or ground water, if a spill occurred. The criteria for this evaluation will include consideration of factors such as the nature and classification of the liquid, qualitative soil permeability, relative topographic position, engineered or designed containment controls, or other physical factors specific to the application.[37]

   Secondary containment requirements could include, as deemed appropriate, one or a combination of the following; dikes, liners, pads, holding ponds, impoundments, curbs, ditches, sumps, receiving tanks, or other equipment capable of containing the substance. The secondary containment should be sufficient to contain 110% of the single largest liquid chemical container within a common staging area.

   Supplementary well permit conditions will also require removal of hydraulic fracturing additives from the site if the site will be unattended.

2) The comprehensive SWPPP that is required by the Department's MSGP (GP-0-06-002) will include Best Management Practices relative to additive containers, mixing and pumping, including, but not limited to, a combination of some or all of the following, or other equally protective practices:

[37] Alpha, 2009, section 2.14

a. Identification of a spill response team and employee training on proper spill prevention and response techniques;

b. Location of additive containers and transport, mixing and pumping equipment as follows:

    i. within secondary containment,

    ii. away from high traffic areas,

    iii. as far as is practical from surface waters,

    iv. not in contact with soil or standing water, and

    v. product and hazard labels not exposed to weathering;

c. Use of troughs, drip pads or drip pots under hose connections;

d. Inspection and preventative maintenance protocols for containers, pumping systems and piping systems, including manned monitoring points during additive transfer, mixing and pumping activities;

e. Protocols for ensuring that incompatible materials such as acids and bases are not held within the same containment area;

f. Procedures for notifying appropriate authorities in the event of a spill;

g. Procedures for immediately stopping the source of the spill and containing the liquid until cleanup is complete;

h. Maintenance of a running inventory of additive products present and used on-site;

i. Ready availability of appropriate spill containment and clean-up materials and equipment including absorbent material;

j. Disposal of cleanup materials in the same manner as the spilled material;

k. Use of dry cleanup methods and non-use of emulsifiers or dispersants;

l. Protocols for checking/testing stormwater in any secondary containment area prior to discharge;

m. Use of drip pads or pans where additives and fracturing fluid are transferred from containers to the blending unit, from the blending unit to the pumping equipment and from the pumping equipment to the well;

n. Use of spill and overflow protection devices,;

o. Use of diversion dikes, berms, curbing, grading or other equivalent measures to minimize or eliminate run-on into additive holding, mixing and pumping areas, and

p. Availability of manual shutoff valves.

7.1.3.4 Flowback Water

The GEIS addresses use of the on-site reserve pit for flowback water associated with a single well. However, even in the single-well case, potential flowback water volumes associated with high-volume hydraulic fracturing exceed GEIS descriptions. Estimates provided in Section 5.11.1 are for 216,000 gallons to 2.7 million gallons of flowback water recovered within two to eight weeks of hydraulic fracturing a single well. The volume of flowback water that would require handling and containment on the site is variable and difficult to predict, and data regarding its likely composition are incomplete. Therefore, the Department proposes a requirement that flowback water handled at the well pad be directed to and contained in steel tanks. Even without this requirement, the pit volume limitation proposed above would necessitate that tank storage be available on site. The Department will also continue to encourage exploration of technologies that promote reuse of flowback water when practical. Additional mitigation measures will be implemented as follows:

1) The EAF Addendum will require information about the number, individual and total capacity and location on the well pad of receiving tanks for flowback water.

2) Supplementary permit conditions for high-volume hydraulic fracturing will include the following requirements:

    a. Fluids removed if there will be a hiatus in site activity longer than 45 days,

    b. Fluids removed within 45 days of completing drilling and stimulation operations at last well on pad, and

    c. Fluid transfer operations from tanks to tanker trucks must be manned at the truck and at the tank if the tank is not visible to the truck operator from the truck.

3) The following additional or more stringent requirements will be included in well permit conditions for multi-well pad high-volume hydraulic fracturing in primary or principal aquifers areas or unfiltered water supply areas.

a. Removal of fluids within 7 days of drilling/stimulation operations for each well;

b. Immediate fluid removal if operations are suspended and the site is left unattended at any time; and

c. Removal of fluids within 7 days of completing drilling and stimulation operations at last well on pad.

4) The comprehensive SWPPP that is required by the Department's MSGP (GP-0-06-002) will include Best Management Practices relative to flowback water tanks, including, but not limited to, a combination of some or all of the following, or other equally protective practices:

a. Identification of a spill response team and employee training on proper spill prevention and response techniques,

b. Location of tanks within secondary containment, away from high traffic areas and as far as is practical from surface waters,

c. Protocols for checking/testing stormwater in any secondary containment area prior to discharge,

d. Maintenance of a running inventory of flowback water recovered, present on site, and removed from the site,

e. Use of troughs, drip pads or drip pots under hose connections that are not within secondary containment,

f. Inspection and preventative maintenance protocols for containers, pumping systems and piping systems, including manned monitoring points during initial flowback operations,

g. Inspection and preventative maintenance protocols for the tanks and associated piping, hoses and valves,

h. Procedures for notifying appropriate authorities in the event of a spill,

i. Procedures for immediately repairing any leak or breach and containing the released liquid until cleanup is complete,

j. Ready availability of appropriate spill clean-up materials and equipment,

k. Disposal of cleanup materials in the same manner as the spilled material, and

l. Use of dry cleanup methods, and non-use of emulsifiers or dispersants

7.1.4 Ground Water Impacts Associated With Well Drilling and Construction

Existing construction and cementing practices and permit conditions to ensure the protection and isolation of fresh water will remain in use, and will be enhanced by Supplementary Permit Conditions for High-Volume Hydraulic Fracturing. See Appendices 8, 9 and 10. Based on discussion in Chapters 2 and 6 of this Supplement, along with GWPC's regulatory review,[38] issues associated with well drilling and construction relate to ground water and include the following:

- Baseline water quality testing of private wells within a specified distance of the proposed well;
- Sufficiency of as-built wellbore construction prior to high-volume hydraulic fracturing, including:
    - Adequacy of surface casing to protect fresh water and to isolate potable fresh water supplies from deeper gas-bearing zones,
    - Adequacy of cement in the annular space around the surface casing,
    - Adequacy of cement on production (and intermediate) casing to prevent upward migration of fluids during all reservoir conditions,
    - Use of centralizers to ensure that the cement sheath surrounds the casing strings, and
    - The opportunity for state regulators to witness casing and cementing operations and
- Prevention of pressure build-up in the annular space between the surface casing and intermediate or production casing.

The proposed well construction-related requirements advanced herein reflect consideration of the following information and sources:

- The 1992 GEIS and its Findings;
- The Department's existing required casing and cementing practices (Appendix 8);

[38] GWPC, 2009b

- The Department's existing supplementary freshwater aquifer permit conditions (Appendix 9);

- Harrison, 1984, with respect to the importance of maintaining the surface-production casing annulus in a non-pressurized condition (a preventative measure which has been implemented as part of the Department's required casing and cementing practices since at least 1985);

- DEC Commissioner's Decision, 1985, regarding well casing cement and the requirement to maintain an open annulus to prevent gas migration into aquifers;

- Ohio Department of Natural Resources, 2008, regarding permit conditions developed to prevent over-pressurized conditions in the surface-production casing annulus;

- GWPC, 2009b, well construction recommendations;

- NYSDOH Recommended Residential Water Quality Testing, Individual Water Supply Wells Fact Sheet #3, relative to recommended water quality testing for all wells and recommended additional parameters to test if gas drilling nearby is the reason for water testing;[39]

- NYSDOH recommendations relative to private water well testing dated July 21, 2009, based on review of fracturing fluid constituents and flowback characteristics;

- URS, 2009, water well testing recommendations based on review of fracturing fluid constituents and flowback characteristics;

- Alpha, 2009, regarding:

    - water well testing requirements in other states identified through a survey of regulations in 10 other jurisdictions, and

    - previous drilling in aquifers, watersheds and aquifer recharge areas; and

- ICF, 2009a, regarding:

    - water well testing recommendations and

    - review of hydraulic fracturing design and subsurface fluid mobility.

[39] http://www.health.state.ny.us/environmental/water/drinking/part5/append5b/fs3_water_quality.htm, accessed 9/16/09

7.1.4.1 Private Water Well Testing

Supplementary permit conditions for high-volume hydraulic fracturing will require the sampling and testing of residential water wells within 1,000 feet of the well pad, subject to the property owner's permission, or within 2,000 feet of the well pad if no wells are available for sampling within 1,000 feet either because there are none of record or because the property owner denies permission. All testing and analysis must be by an ELAP-certified laboratory,[40] and the results of each test must be provided to the property owner and the county health department prior to commencing drilling operations.

Schedule

Testing before drilling provides a baseline for comparison in the event that water contamination is suspected. Testing prior to drilling each well at a multi-well pad provides ongoing monitoring between drilling operations, so the requirement will be attached to every well permit that authorizes high-volume hydraulic fracturing. Testing at established intervals after drilling or hydraulic fracturing operations provides opportunities to detect contamination or confirm its absence. If no contamination is detected a year after the last hydraulic fracturing event on the pad, then further routine monitoring should not be necessary. The Department proposes the following ongoing monitoring schedule:

- Initial sampling and analysis prior to site disturbance at the first well on the pad, and prior to drilling commencement at additional wells on multi-well pads;
- Sampling and analysis three months after reaching total measured depth (TMD) at any well on the pad if there is a hiatus of longer than three months between reaching TMD and any other milestone on the well pad that would require sampling and analysis; and
- Sampling and analysis three months, six months and one year after hydraulic fracturing operations at each well on the pad.

For multi-well pads where drilling and hydraulic fracturing activity is continuous, to the extent that water well sampling and analysis according to the above schedule would occur more often than every three months, then the Department proposes to simplify the protocol so that sampling and analysis occurs at three month intervals until six months after the last well on the pad is

[40] http://www.wadsworth.org/labcert/elap/elap.html, accessed 9/16/09

hydraulically fractured, with a final round of sampling and analysis one year after the last well on the pad is hydraulically fractured.

More frequent sampling and analysis, or sampling and analysis beyond one year after last hydraulic fracturing operations, may be warranted in response to complaints as described below.

Parameters

The New York State Department of Health recommends water well testing as set forth in Table 7.1 prior to using a new residential water well. DEC proposes that the same parameters also be tested prior to high-volume hydraulic fracturing, in order to establish a baseline and to ensure that pre-existing conditions are adequately characterized.

Table 7.3 - NYSDOW Water Well Testing Recommendations[41]

Analysis	Recommended MCL[42,43]	Concerns
Coliform Bacteria	Any positive result is unsatisfactory	Indicator of possible disease-causing contamination, e.g. Gastro-intestinal illness
Lead	0.015 mg/l	Brain, nerve and kidney damage (especially in children)
Nitrate	10 mg/l as N	Methemoglobinemia ("blue baby syndrome")
Nitrite	1 mg/l as N	Methemoglobinemia ("blue baby syndrome")
Iron	0.3 mg/l	Rust-colored staining of fixtures or clothes
Manganese	0.3 mg/l	Black staining of fixtures or clothes
Iron plus manganese	0.5 mg/l	Rusty or black staining of fixtures or clothes
Sodium	No designated limit[44]	Effects on individuals with high blood pressure
pH	No designated limit	Pipe corrosion (lead and copper), metallic-bitter taste
Hardness	No designated limit	Mineral and soap deposits, detergents are less effective
Alkalinity	No designated limit	Inhibits chlorine effectiveness, metallic-bitter taste
Turbidity	5 NTU	Cloudy, "piggybacking" of contaminants, interferes with chlorine and UV-light disinfection

Based on recommendations from the sources (including NYSDOH) cited above, that reviewed fracturing additive and flowback water composition data provided to the Department and

[41] http://www.health.state.ny.us/environmental/water/drinking/part5/append5b/fs3_water_quality.htm, accessed 9/16/09

[42] MCL means maximum contaminant level. The MCLs listed are based upon requirements for Public Water Supply systems and are also recommended for use on individual residential systems.

[43] mg/l means milligram per liter (parts per million); NTU means Nephelometric Turbidity Units

[44] Water containing more than 20 mg/l of sodium should not be used for drinking by people on severely restricted sodium diets. Water containing more than 270 mg/l of sodium should not be used by people on moderately restricted sodium diets.

summarized in Chapters 5 and 6, the following additional testing parameters have been identified:

- Static water level
- Total dissolved solids (TDS)
- Total suspended solids (TSS)
- Chlorides
- Carbonates
- Bicarbonates
- Sulfate
- Barium
- Strontium
- Arsenic
- Surfactants
- Methane
- Hydrogen sulfide
- Benzene
- Gross alpha
- Gross beta

Contaminant-indicators should be included in the initial, pre-drilling or baseline round of sampling to ensure that pre-existing conditions are considered in response to complaints of suspected contamination. Of the above parameters, barium, TDS and pH are identified as those which could initially suggest contamination as a result of the fracturing operation. Monitoring for strontium, sodium, chloride, hardness, surfactants, TSS, iron, carbonates and bicarbonates could provide a better understanding of the extent of potential contamination. As diesel-based fracturing fluid is not proposed or reviewed by this Supplement, the primary reason for its inclusion is to indicate above-ground fuel spills.[45] NYSDOH Bureau of Environmental Radiation Protection staff indicates that total gross alpha activity is an inexpensive (but effective) screening tool, and would indicate the need for additional analysis if the value is greater than 15 pCi/L. Analysis of changes in static water level should carefully consider the well's construction, maintenance and operational history, recent precipitation and use patterns, the season and the effects of competing wells.

[45] URS, p. 8-4

Complaints

As noted in the GEIS:

> The diversity of jurisdictions having authority over local water supplies complicates the response to complaints about water supplies, including those complaints that complainants believe are related to oil and gas activity. Water supply complaints occur statewide and take many forms, including taste and turbidity problems, water quantity problems, contamination by salt, gasoline and other chemicals and problems with natural gas in water wells. All of these problems, including natural gas in water supplies, occur statewide and are not restricted to areas with oil and gas development.[46]

and:

> The initial response to water supply complaints is best handled by the appropriate local health office, which has expertise in dealing with water supply problems.[47]

Under the proposed protocols, county health departments will receive the results of baseline testing and ongoing monitoring that occurs until a year after the last hydraulic fracturing operations on a well pad. Therefore, they remain in the best position to investigate initial water well complaints from residential well users. The Department has MOUs in place with several county health departments in western NY whereby the county health department initially investigates a complaint and then refers it to DEC when a problem has been verified and other potential causes have been ruled out. For complaints that occur more than a year after the last hydraulic fracturing operations on a well pad within the radius where baseline sampling occurred (1,000 feet or 2,000 feet), or for complaints regarding water wells that are more than 2,000 feet away from any well pad, the Department proposes to follow this procedure statewide. Complaints would be referred to the county health department, who would refer them back to DEC for investigation when a problem has been verified and other potential causes have been ruled out. Sampling and analysis to verify and evaluate the problem would be according to protocols that are satisfactory to the county health department, with advice from NYSDOH as necessary.

[46] GEIS, pp. 15-4 et seq.

[47] GEIS, p. 15-5

Complaints that occur during active operations at a well pad within 2,000 feet or the radius where baseline sampling occurred, or within a year of last hydraulic fracturing at such a site, should be jointly investigated by DEC and the county health department. Mineral Resources staff shall conduct a site inspection, and if a complaint coincides with any of the following documented potentially polluting non-routine well pad incidents, then the Department will consider the need to require immediate cessation of operations, immediate corrective action and/or revisions to subsequent plans and procedures on the same well pad, in addition to any applicable formal enforcement measures:

- Surface chemical spill;
- Fracture equipment failure;
- Observed leaks in surface equipment onto the ground , into stormwater runoff or into a surface waterbody;
- Observed pit liner failure;
- Significant lost circulation or fresh water flow below surface casing;
- The presence of brine, gas or oil zones not anticipated in the pre-drilling prognosis;
- Evidence of a gas-cut cement job;
- Anomalous flow or pressure profile during fracturing operations;
- Any non-routine incident listed in ECL §23-0305(8)(h) (i.e., casing and drill pipe failures, casing cement failures, fishing jobs, fires, seepages, blowouts); or
- Any violation of the ECL, its implementing rules and regulations, or any permit condition, including the requirement that the annulus between the surface casing and the next casing string be maintained in a non-pressurized condition.

DEC and the county health department will share information. All data on file with the county health department relative to the subject water well, including pre-existing conditions and any available information about the well's history of use and maintenance, shall be considered in determining the proper course of action with respect to well pad activities.

7.1.4.2 Sufficiency of As-Built Wellbore Construction

Wellbore construction is addressed by the existing GEIS. While the same concepts apply to wells used for high-volume hydraulic fracturing, some enhancements are proposed because of the high pressures that will be exerted, the large fluid volumes that will be pumped and potential concentration of the activity in areas without much subsurface well control.

Surface Casing

As defined in regulations, the purpose of surface casing is to protect potable fresh water.[48] For oil and gas regulatory purposes, potable fresh water is defined as water containing less than 250 parts per million of sodium chloride or 1,000 parts per million of total dissolved solids.[49] As stated in Chapter 2, maximum depth of potable water in an area should be determined based on the best available data. This would include water wells and other oil and gas wells in the area, any available local or regional geological or hydrogeological reports, and information gleaned from the sources listed in Section 7.1.10.1. When information is not available, a depth of 850 feet to the base of potable water is a commonly used and practical generalization.

Current casing and cementing practices attached as conditions to all oil and gas permits require:

- surface casing shall extend at least 75 feet beyond the deepest fresh water zone encountered or 75 feet into bedrock, whichever is deeper, and deeply enough to allow the blow-out preventer stack to contain any formation pressures that may be encountered before the next casing is run;

- surface casing shall not extend into zones known to contain measurable quantities of shallow gas, and, in the event such a zone is encountered before the fresh water is cased off, the operator shall notify the Department and take Department-approved actions to protect the fresh water zone(s); and

- surface casing shall consist of new pipe with a mill test of at least 1,000 pounds per square inch, or used casing that is pressure tested before drilling ahead after cementing; welded pipe must also be pressure tested.

The following more stringent requirements are implemented as permit conditions in primary and principal aquifers:

[48] 6 NYCRR 550.3(au)

[49] 6 NYCRR 550.3(ai)

- surface casing hole must be drilled on air, fresh water or fresh water mud;

- surface casing must extend at least 100 feet below the deepest fresh water zone and at least 100 feet into bedrock;

- pipe must be either new API graded pipe with a minimum internal yield pressure of 1,800 pounds per square inch or reconditioned pipe that has been tested internally to a minimum of 2,700 psi; and

- if multiple fresh water zones are known to exist or are found or if shallow gas is present, multiple strings of surface casing may be required to prevent gas intrusion and/or preserve the hydraulic characteristics and water quality of each fresh water zone. Notification to the Department is required of the occurrence of fresh water or shallow gas zones not noted in the well permit application materials and prognosis, and the Department may require changes to the casing and cementing plan and may also require the immediate, temporary cessation of operations while such changes are developed, evaluated and approved.

All of the above requirements will remain in effect, enhanced as follows by the attachment of Supplementary Permit Conditions for High-Volume Hydraulic Fracturing:

1) The Supplementary Permit Conditions will require submission of a *Pre-Frac Checklist and Certification Form* (pre-frac form) at least 48 hours prior to commencement of high-volume hydraulic fracturing operations. Regarding the surface casing hole, the pre-frac form will:

    a. attest to well construction having been performed in accordance with the well permit or approved revisions,

    b. list the depth and estimated flow rates where fresh water, brine, oil and/or gas were encountered or circulation was lost during drilling operations, and

    c. include information about how any lost circulation zones were addressed.

Hydraulic fracturing will not be authorized to proceed without the above information and certifications.

Surface Casing Cement

Current casing and cementing practices attached as conditions to all oil and gas permits require:

- cementing by the pump and plug method and circulation to surface,

- minimum of 25% excess cement pumped, with appropriate lost circulation materials,

- testing of the mixing water for pH and temperature prior to mixing,
- cement slurry preparation to the manufacturer's or contractor's specifications to minimize free water in the cement, and
- no casing disturbance after cementing until the cement achieves a calculated compressive strength of 500 pounds per square inch.

The following more stringent requirements are implemented as permit conditions in primary and principal aquifers:

- minimum of 50% excess cement pumped, with appropriate lost circulation materials,
- squeezing or grouting from the surface, or through perforations, if circulation is not achieved and
- remedial action prior to drilling out of and below the surface casing if there is any evidence or indication of flow behind the surface casing.

All of the above requirements will remain in effect, enhanced as described above by the requirement in Supplementary Permit Conditions for a pre-frac form prior to high-volume hydraulic fracturing.

Intermediate and Production Casing Cement

Current casing and cementing practices set requirements for production casing cement and state that intermediate casing cement requirements will be reviewed and approved on an individual well basis. The requirements for production casing cement are as follows:

- Cement must extend at least 500 feet above the casing shoe or tie into the previous casing string, whichever is less;
- If any oil or gas shows are encountered or known to be present in the area, as determined by the Department at the time of permit application, or subsequently encountered during drilling, the production casing cement shall extend at least 100 feet above any such shows;
- Weighted fluid may be used in the annulus to prevent gas migration in specific instances when the weight of the cement column could be a problem;

- Cementing shall be by the pump and plug method for all jobs deeper than 1,500 feet, with a minimum of 25% excess cement unless caliper rugs are run, in which case 10% excess will suffice;

- The mixing water shall be tested for pH and temperature prior to mixing; and

- Following cementing and removal of cementing equipment, the operator shall wait until a compressive strength of 500 pounds per square inch is achieved before the casing is disturbed in any way.

The above requirements will remain in effect, enhanced as follows by the attachment of Supplementary Permit Conditions for High-Volume Hydraulic Fracturing:

1) The pre-frac form will be required as described above;

2) If intermediate casing is not installed, then production casing must be fully cemented to surface. If intermediate casing is installed, it must be fully cemented to surface, and production casing cement must be tied into the intermediate casing string with at least 300 feet of cement. Any request to waive the preceding requirement must be made in writing with supporting documentation and is subject to the Department's approval. The Department will only approve a waiver if open hole wireline logs and all other information collected during drilling from the same well pad verify that migration of oil, gas or other fluids from one pool or stratum to another will otherwise be prevented. In any event, the top of cement on the production casing must be at least 500 feet above the casing shoe or tied into the previous casing string with at least 300 feet of cement.

3) The operator must run a cement bond log to verify the cement bond on the intermediate casing, if any, and the production casing. Remedial cementing shall be required if the cement bond is not adequate to isolate hydraulic fracturing operations.

Centralizers

The use and purpose of centralizers, as recommended by GWPC, is to keep the casing centered in the wellbore so that cement adequately fills the space around it. Current casing and cementing practices attached as conditions to all oil and gas drilling permits require use of centralizers on all casing strings and specify adequate hole diameters and spacing for their use. Centralizers are required every 120 feet on surface casing, but no fewer than two may be run. These requirements will continue to apply to wells drilled for high-volume hydraulic fracturing.

Inspections to Witness Casing and Cementing Operations

Current casing and cementing practices attached as conditions to all oil and gas well drilling permits require notification to the Department prior to any surface casing pressure test. In

primary and principal aquifer areas, the Department must be notified prior to surface casing cementing operations and cementing cannot commence until a state inspector is present. These requirements will continue to apply to wells drilled for high-volume hydraulic fracturing. Supplementary Permit Conditions for High-Volume Hydraulic Fracturing will require notification prior to surface casing cementing for all wells, so that Department staff has the opportunity to witness the operations.

7.1.4.3 Annular Pressure Buildup

Current casing and cementing practices require that the annular space between the surface casing and the next string be vented at all times to prevent pressure build-up in the annulus. If the annular gas is to be produced, a pressure relieve valve shall be installed in an appropriate manner and set at a pressure approved by the Department. Proposed Supplementary Permit Conditions for High-Volume Hydraulic Fracturing state that "under no circumstances should the annulus between the surface casing and the next casing string be shut-in, except during a pressure test."

7.1.5 Hydraulic Fracturing Procedure

As detailed in Section 6.15, potential impacts to ground water from the high-volume hydraulic fracturing procedure itself are, in most cases, not reasonably anticipated. To the extent that any could occur, mitigation is provided by all of the enhanced requirements proposed as Supplementary Permit Conditions for High-Volume Hydraulic Fracturing and discussed above. These include:

- Requirement for private water well testing;
- Pit construction and liner specifications for well pad reserve pits;
- Requirement that tanks be used to contain flowback water on site;
- Appropriate secondary containment measures;
- Removal of fluids within specified time frames;
- Use of appropriate pressure-control procedures and equipment, including blow-out prevention equipment that is tested on-site prior to drilling ahead and fracturing equipment that is pressure tested with fresh water ahead of pumping fracturing fluid;

- Requirement for notification to DEC prior to cementing surface casing;
- Requirements for cement to surface and a cement bond log;
- Use of a the pre-frac form to certify wellbore integrity prior to fracturing; and
- Pre-fracturing pressure testing of casing from surface to top of treatment interval.

In addition, the Department will continue to require that the annulus between the surface casing and the next casing string not be shut-in, except during a pressure test, and more stringent surface casing and cementing practices, fluid removal practices and inspection requirements in primary and principal aquifer areas.

As explained in Section 6.1.5.2, the conclusion that harm to freshwater aquifers from fracturing fluid migration is not reasonably anticipated is contingent upon the presence of certain natural conditions, including 1,000 feet of vertical separation between the bottom of a potential aquifer and the top of the target fracture zone. In addition, as stated in Section 5.18.1.1, GWPC recommended a higher level of scrutiny and protection for shallow hydraulic fracturing or when the target formation is in close proximity to underground sources of drinking water. Therefore, the Department proposes that site-specific SEQRA review be required for the following projects:

1) any proposed high-volume hydraulic fracturing where the top of the target fracture zone at any point along the entire proposed length of the wellbore is shallower than 2,000; and

2) any proposed high-volume hydraulic fracturing where the top of the target fracture zone at any point along the entire proposed length of the wellbore is less than 1,000 feet below the base of a known fresh water supply.

Review would focus on local geological, topographical and hydrogeological conditions, along with proposed fracturing procedures to determine the potential for a significant adverse impact to fresh ground water. The need for a site-specific supplemental environmental impact statement will be determined based upon the outcome of the review.

7.1.6 Waste Transport

7.1.6.1 Drilling and Production Waste Tracking Form

Because of the anticipated high volume of flowback water compared to traditional operations, the paucity of reliable data regarding flowback water and production brine composition, NORM concerns, the number of wells that may be drilled and the current limited disposal options, the Department will require that a *Drilling and Production Waste Tracking Form* be completed and maintained by generators, haulers and receivers of all flowback water associated with activities addressed by this Supplement. The record-keeping requirements and level of detail will be similar to what is presently required for medical waste.[50] The form will be required regardless of whether waste is taken to a treatment facility, disposal well, centralized surface impoundment, another well pad, a landfill, or elsewhere.

7.1.6.2 Road Spreading

Flowback Water

As explained in Chapter 5 and presented in Appendix 12, consistent with past practice, the Department began in January 2009 notifying Part 364 haulers applying for, modifying, or renewing their Part 364 permit that flowback water may not be spread on roads and must be disposed of at facilities authorized by the Department or transported for use or re-use at other gas or oil wells where acceptable to the Division of Mineral Resources.

Produced Brine

The notification described above puts Part 364 haulers on notice that any entity applying for a Part 364 permit or permit modification to use production fluid for road spreading must submit a petition for a beneficial use determination ("BUD") to the Department. For production fluids that will be used on roads, the BUD and Part 364 permit must be issued by the Department prior to the removal of any production brine from the well site. As set forth in the notification, the BUD petition must include analytical results from a NYSDOH laboratory of a representative sample for the following parameters: calcium, sodium, chloride, magnesium, total dissolved solids, pH, iron, barium, lead, sulfate, oil & grease, benzene, ethylbenzene, toluene, and xylene. Dependent upon the analytical results, the Department may require additional analyses.

[50] http://www.dec.ny.gov/docs/materials_minerals_pdf/medwste.pdf

The foregoing list of analysis parameters is not unique or specific to production brine from the Marcellus or any other particular rock formation, but is meant to be inclusive of all potential produced brines. For Marcellus production brine, the Department will add a radioactivity scan as set forth in Section 7.1.81 of this Supplement, and the BUD petition will be denied if levels indicate a potential public exposure concern.

7.1.6.3 Flowback Water Piping

Flowback water piping and conveyances between well pads and centralized flowback water facilities (or any other destination) must be described in the fluid disposal plan required by 6 NYCRR 554.1(c)(1) and the MSG SWPPP. The fluid disposal plan must demonstrate that pipelines and conveyances will be constructed of suitable materials, maintained in a leak-free condition, regularly inspected and operated using all appropriate spill control and stormwater pollution prevention practices.

7.1.7 Centralized Flowback Water Surface Impoundments

The Department's regulations require submission and approval for a fluid disposal plan "[p]rior to the issuance of a well drilling permit for any operation in which the probability exists that brine, salt water or other polluting fluids will be produced or obtained during drilling operations in sufficient quantities to be deleterious to the surrounding environment . . ."[51] Consequently, the EAF Addendum will require information on the disposition of flowback water. Any proposed centralized surface impoundment will be considered part of the project for the first well permit application that proposes its use. All well permit applications proposing use of a centralized flowback water surface impoundment will be considered incomplete until the Department has approved the surface impoundment. Consistent with GWPC's recommendation that long-term storage pits be prohibited within the boundaries of public water supplies (Section 5.18.1.2), the Department will not approve use of centralized flowback water surface impoundments within the boundaries of primary and principal aquifers or unfiltered water supplies (e.g., the NYC Watershed).

[51] 6 NYCRR 554.1(c)(1)

To address the potential environmental impacts identified in Section 6.1.7, standards from two of the Department's regulatory programs will be applied to review of proposed centralized flowback water surface impoundments.

First, if dam safety permitting criteria based on the height and storage capacity of the surface impoundment are met (see Figure 5.5), then construction must be in accordance with the Department's technical guidance document, *Guidelines for Design of Dams.*[52] Operation must be in accordance with the Department's document, *An Owner's Guidance Manual for the Inspection and Maintenance of Dams in New York State.*

Second, upon review of the existing regulatory framework for liquid containment, the Department has determined that the existing regulatory structure established for solid waste management facilities, 6 NYCRR Part 360 (Part 360), is most applicable for the containment, operational, monitoring and closure requirements for centralized flowback water management facilities.[53] While it is acknowledged that flowback waters are not solid wastes, the characteristics of the flowback waters best compare qualitatively with landfill leachate regulated under the Part 360 provisions. The liner requirements as they exist in Part 360 have been proven through time to be conservative and, more importantly, have been determined to provide the requisite level of protection to ensure preservation of the ground water quality resources at solid waste management facilities throughout the State. Therefore, the Department will apply the existing Part 360 standards as described below to its review of centralized flowback water surface impoundments pursuant to 6 NYCRR 554.1(c)(1).

As with all environmental containment systems, it is acknowledged that conservative liner requirements alone do not guarantee groundwater protection. Emphasis has to be placed on the importance of proper facility design, material selection, construction quality and facility operation and monitoring. All are equally important to best ensuring successful protection of the groundwater resources of New York State.

---

[52] *Guidelines for Design of Dams*is available on the Department's website at http://www.dec.ny.gov/docs/water_pdf/damguideli.pdf or upon request from the DEC Regoinal Permit Administrator.

[53] Part 360 regulations: http://www.dec.ny.gov/regs/2491.html

The specific provisions of Subpart 360-6 Liquid Storage will provide the overall requirements for either flowback surface impoundments or tanks, describing the minimum liner, operational, monitoring and closure requirements. These provisions will cross reference other applicable provisions of Part 360 which more specifically address liner system design, construction materials, construction quality assurance and construction certification requirements that likewise will be applicable to the flowback water containment systems discussed in the dSGEIS.

7.1.7.1 Purpose of a Double-Liner System

The best way to ensure that leakage is prevented in lined facilities is to minimize the hydraulic head on the liner system. In crafting the liquid containment requirements of Part 360, the Department determined that the best approach is to use a double liner system. In doing so, a certain amount of leakage is allowed through the upper liner system into a lower leak removal, detection and monitoring system which is designed to be free-flowing such that the rate of leakage withdrawal from the leak detection system prevents any appreciable hydraulic head from building up on the lower most liner system.

To help prevent damage from unstable ballast materials, a double liner system with a properly designed leak detection and monitoring system will not necessarily require large amounts of ballast material on the upper liner system as long as the leak detection and removal system functions such that no upward hydraulic pressures are imposed on the upper liner system. This mitigates concerns for damage from unstable ballast materials as described in Section 6.1.7.

7.1.7.2 Liner Materials

The provisions of subdivision 360-2.14(a) for non-hazardous industrial waste facilities allows the Department to exercise site-specific judgment and flexibility on liner, operational and closure requirements for certain industrial waste materials without the need for regulatory variance determinations. In establishing the specific requirements for the flowback water management based on the general flowback water characterization and the temporary nature of these facilities, Department staff may consider proposals to use alternate materials in constructing these facilities. For instance, design engineers have latitude in the geomembrane polymer selection based on the individual application, provided the following requirements are met:

- High Density Polyethylene Geomembranes must be a minimum thickness of 60 mils thick for adequate ability to field seam the material.

- Linear Low Density Polyethylene Geomembranes must be a minimum thickness of 40 mils for adequate ability to field seam the material.

- Polyvinyl Chloride (PVC) must be minimum thickness of 30 mils thick and must be double hot wedge seamed and all field seams tested using the air channel test.

- Certain reinforced geomembrane polymers also may be considered, in light of the durable nature of scrim-reinforced geomembranes which makes them more ideal for exposed applications.

Subpart 360-6 requires that the lowermost liner of a double lined surface impoundments be a composite liner which consists of a 2-foot thick low permeability compacted clay soil barrier overlain by and in direct contact with a geomembrane. The composite liner greatly reduces the effects of leakage from any geomembrane liner defects. However, the relative short-term nature of the surface impoundments compared to landfills and the anticipated quality of the flowback waters supports use of subdivision 360-2.14(a) to allow, at the design engineers discretion, the substitution of a geosynthetic clay liner (GCL) in lieu of the 2-foot thick compacted clay barrier in the composite. This latitude will ease construction and reduce construction related truck traffic if low permeability soil is not available in the area.

7.1.7.3 Application of Section 360-6.5 Double Liner Requirements

The lowermost liner for a centralized flowback water surface impoundment must be a single composite liner and may be designed with a GCL in lieu of the 2 foot thick compacted low permeability soil ($1 \text{ X } 10^{-7}$ cm/sec) specified in regulations. The GCL must be directly below a geomembrane, which in turn would be overlain by an appropriately designed and specified geocomposite drainage system. The drainage system must be designed to be free flowing and be capable of monitoring flows for liner performance. Above this leak detection layer would be another geomembrane liner that would be selected by the design engineer to address durability matters associated with exposure concerns if the upper geomembrane is left exposed.

The design engineer will be required to submit a construction quality control and construction quality assurance plan and perform final certification reporting upon completion of construction in accordance with the applicable provisions of Section 360-2.13.

The maximum leakage rate monitored between the two liner systems should not exceed 100 gallons per acre per day (based on a 30-day average). The facility owner shall notify the Department within 7 days of the determination of exceedance and submit a report within 14 days of the exceedance detailing a plan for corrective action and repairs of the liner system's performance. Final repair and certification of the repair must be submitted by a licensed professional engineer and approved by Department prior to putting the surface impoundment back into service.

Quality construction and installation needs to be assured. Construction problems will be immediately evident with the double liner system. Literature reveals that 97 percent of all geomembrane defects occur during facility construction. If a surface impoundment experiences high leakage rates at the beginning of operations, impoundment usage would need to be curtailed until repairs are made. This typically results in costly delays. Consideration should be given to use of electrical leak location services prior to putting the surface impoundment into service. Many landfill owners require this as part of the construction quality assurance testing to minimize delays in putting the landfill into service. This approach also makes sense for surface impoundments.

7.1.7.4 Use of Tanks Instead of Impoundments for Centralized Flowback Water Storage

Above ground storage tanks have some advantages over surface impoundments. The Department's experience is that landfill owners prefer above ground storage tanks over surface impoundments for storage of landfill leachate. Tanks, while initially are more expensive, experience fewer operational issues associated with liner system leakage. In addition, tanks can be easily covered to control odors and air emissions from the liquids being stored. Precipitation loading in a surface impoundment with a large surface area can, over time, increase the volumes of liquid needing treatment. Lastly, above ground tanks also can be dismantled and reused. The provisions of Section 360-6.3 address the minimum regulatory requirements applicable to above ground storage tanks which would be equally applicable for adequate flowback water containment as well.

7.1.7.5 Closure Requirements

The closure requirements for liquid storage facilities under Subpart 360-6 are specified in section 360-6.6 Closure of Liquid Storage Facilities. These provisions detail the specific closure requirements for these containment structures and require any post-operation residues to be properly handled and disposed of as part of the process.

7.1.8 SPDES-Regulated Discharges

Flowback water and production brine are considered industrial wastewater. Wastewater is generated by many water users and industries. NYSDEC's EPA-approved program for the control of wastewater discharges is called the State Pollutant Discharge Elimination System and is commonly referred to as SPDES. The program controls point source discharges to ground waters and surface waters.

7.1.8.1 Treatment Facilities

SPDES permits are issued to wastewater dischargers, including treatment facilities such as Publically Owned Treatment Works (POTW's) operated by municipalities. SPDES permits include specific discharge limitations and monitoring requirements. The effluent limitations are the maximum allowable concentrations and/or mass loadings for various physical, chemical, and/or biological parameters to ensure that there are no impacts to the receiving water body.

POTWs

A POTW must have an approved pretreatment program, or mini-pretreatment program, developed in accordance with the above requirements in order to accept industrial wastewater from non-domestic sources covered by Pretreatment Standards which are indirectly discharged into or transported by truck or rail or otherwise introduced into POTWs.

The NYSDEC's Division of Water shares pretreatment program oversight (approval authority) responsibility with the USEPA. Indirect discharges to POTWs are regulated by 6NYCRR Part 750-2.9(b), National Pretreatment Standards, which incorporates by reference the requirements set forth under 40CFR Part 403, "General Pretreatment Regulations for Existing and New Sources of Pollution." In accordance with Division of Water TOGS 1.3.8, 6NYCRR Part 750-2.9, 40CFR Part 403, and 40 CFR 122.42, New York State POTW permittees with industrial

pretreatment or mini-pretreatment programs are required to notify NYSDEC of new discharges or substantial changes in the volume or character of pollutants discharged to the permitted POTW. NYSDEC must then determine if the SPDES permit needs to be modified to account for the proposed discharge, change or increase.

Flowback water and production brine from wells permitted pursuant to this Supplement may only be accepted by POTWs with approved pretreatment or mini-pretreatment programs, as noted above, and an approved headworks analysis for this wastewater source as described below and as required by the POTW's State Pollutant Discharge Elimination System (SPDES) permit.

Appendix 21 is a list of POTW's with approved pretreatment and mini-pretreatment programs. In addition, any industrial wastewater source, including this source of wastewater, may only be discharged utilizing all treatment processes within the POTW. Admixture of untreated flowback water or other well development water to the treated effluent of the POTW is not allowed. Improper handling could result in noncompliance with terms of the permit or the Environmental Conservation Law and result in formal enforcement actions.

The large volumes of return water from high-volume hydraulic fracturing combined with the diverse mixture of chemicals and high total dissolved solids (TDS) that exist in both flowback water and produced brine, requires that the permittee submit a headworks analysis to the Department for review in accordance with DOW's Technical and Operational Guidance Series(TOGS)1.3.8. New Discharges to Publicly Owned Treatment Works. TOGS 1.3.8 was developed to assist NYSDEC permit writers in evaluating the potential effect of a new, substantially increased, or changed non-domestic discharge to a POTW on that facility's SPDES permit and pretreatment program. The DOW must determine whether the POTW has adequately evaluated the effects of the proposed discharge on POTW operation, sludge disposal, effluent quality, and POTW health and safety; whether the discharge will result in the discharge of a substance that will be subject to effluent limits, action levels, or other monitoring requirements in the facility's SPDES permit; and whether the proposed discharge contains any Bioaccumulative Chemicals of Concern or persistent toxic substances that may be subject to SPDES effluent limits or other Departmental permit requirements or controls. Appendix C of TOGS 1.3.8, *Guidance for Acceptance of New Discharges*, describes the analyses and submittals necessary for

a POTW to accept a new source of wastewater. Note that if a facility has a currently approved headworks analysis in place for the parameters and concentrations of those parameters typically found in flowback water and produced brine, the permittee may assess the impacts of the proposed discharge against the existing headworks analysis.

Flowback water and produced brine must be fully characterized prior to acceptance by a POTW for treatment. Please note in particular Appendix C. IV of TOGS 1.3.8, "Maximum Allowable Headworks Loading (MAHW)." Flowback water or produced brine may contain inhibitory amounts of dissolved solids, as well as an elevated pH, residual hydraulic fracturing additives, heavy metals, and potentially barium or other radioactive substances. The POTW should perform a MAHW analysis to assure that the flowback water and produced brine will not cause a violation of the POTW's effluent limits or sludge disposal criteria, allow pass through of unpermitted substances or inhibit the POTW's treatment processes. As a result, the SPDES permits for POTWs that accept this source of wastewater will be modified to include effluent limits for TDS, if not already identified in the existing SPDES permit, as well as for other parameters as necessary to ensure that the permit correctly and completely characterizes the discharge.

Specific information regarding these fluids, such as chemical makeup and aquatic toxicity, will be required for this analysis. DOW has developed the form in Appendix 22 (Hydrofracturing Chemical Form HFC) which may be used to simplify and expedite the evaluation process. The form must be submitted for each proposed chemical to identify active ingredients and toxicity of fracturing additives or formation constituents that may be present in the wastewater. If any confidentiality is allowed under State law based upon the existence of proprietary material, that fact may be noted in the submission. However, in no circumstance shall a fracturing additive be approved or evaluated in a headworks analysis without aquatic toxicity data. Department approval of the headworks analysis, and the modification of the POTW's SPDES permit if necessary, must be received prior to the acceptance of flowback water or produced brine from wells permitted pursuant to this Supplement.

In conducting the headworks analysis, the parameters that must be analyzed include, at a minimum:

- constituents that were present in the hydraulic fracturing additives
- pH, range, SU

- Oil and Grease
- Solids, Total Suspended
- Solids, Total Dissolved
- Chloride
- Sulfate
- Alkalinity, Total (CaCO3)
- BOD, 5 day
- Chemical Oxygen Demand (COD)
- Total Kjeldahl Nitrogen (TKN)
- Ammonia, as N
- Total Organic Carbon
- Phenols, Total
- and the following scans:
    - Priority Pollutants Metals
    - Priority Pollutants Volatiles
    - Priority Pollutants SVOC Base/Neutral
    - Priority Pollutants SVOC Acid
- Radioactive scan including:
    - Gross Alpha - EPA Method 900.0, Standard Methods 7110-B
    - Gross Beta - EPA Method 900.0, Standard Methods 7110-B
    - Radium - EPA Method 903.0, Standard Methods 7500-Ra B
    - Uranium - EPA Method 908, Standard Methods 7500-U
    - Thorium - EPA Method 910, Standard Methods 7500-Th

The high concentrations of Total Dissolved Solids (TDS) present in this source of wastewater may prove to be inhibitory to biological wastewater treatment processes. It has been noted that the concentrations of TDS in the return and process water increase over the life of the well. The expected concentrations of TDS for both the initial flowback water as well as for the ongoing well operation must therefore be considered in the development of the headworks analysis. It is incumbent upon the POTW to determine whether the volumes and concentrations of chemicals present in the flowback water or production brine would result in adverse impacts to the facility's treatment processes as part of the above headworks analysis.

Private Treatment Facilities

Privately owned facilities for the treatment and disposal of industrial wastewater from high-volume hydraulic fracturing operate in other states, including Pennsylvania. Similar facilities that might be constructed in New York would require a SPDES permit. Again, the SPDES permit for a dedicated treatment facility would include specific discharge limitations and monitoring requirements. The effluent limitations are the maximum allowable concentrations or

ranges for various physical, chemical, and/or biological parameters to ensure that there are no impacts to the receiving water body.

7.1.8.2 Disposal Wells

Because of the 1992 Finding that brine disposal wells require site-specific SEQRA review, mitigation measures are discussed here for informational purposes only and are not being proposed on a generic basis.

Flowback and disposal strata water quality must be fully characterized prior to permitting and injecting into a disposal well. Additional geotechnical information regarding the disposal strata's ability to accept and retain the injected fluid is also necessary. Form HFC, in Appendix 22, may be used to simplify and expedite the water quality evaluation process. The water quality parameters that must be analyzed are the same as those listed in Section 7.1.8.1 and additional information regarding the use of Form HFC is presented in that section.

The Department may propose monitoring requirements and/or discharge limits in the SPDES permit in addition to any requirements included in the required USEPA Underground Injection Control permit. These will be determined during the site-specific permitting process required by the Uniform Procedures Act and the 1992 Findings Statement. To be protective of the overlying potable water aquifers, the site-specific permitting process will consider the following topics:

- Distance to drinking water supplies or sources, surface waterbodies and wetlands.
- Topography, geology, and hydrogeology.
- The proposed well construction and operation program.
- Water quality analysis of the receiving stratum for TDS, chloride, sulfate and metals.
- Effluent limits for injectate constituents, and potential applicability of 6 NYCRR 703.6 groundwater effluent limits or the groundwater effluent guidance values listed in Division of Water TOGS 1.1.1.
- Potential requirement for upgradient and downgradient monitoring wells installed in the deepest identified GA or GSA potable water aquifer.

7.1.9 Solids Disposal

Cuttings may be managed within a closed loop system or discharged to the lined reserve pit. If cuttings are discharged to the reserve pit and a common reserve pit is used for multiple wells on the pad, cuttings may have to be removed several times to maintain the required two feet of freeboard set forth in Section 7.1.3.2. Care must be taken during this operation not to damage the liner.

Cuttings or a pit liner contaminated with oil-based mud must not be buried on site, but must be removed for disposal in a Part 360 solid waste facility. Supplementary permit conditions for high-volume hydraulic fracturing require consultation with the Department's Division of Solid and Hazardous Materials.

One operator has suggested annular disposal of drill cuttings. This is not an acceptable practice in New York and would not be approved.

Although not directly related to a water resources impact, consideration also should be given to monitoring and mitigating subsidence by adding fill as any uncontaminated drill cuttings that are buried on site dewater and consolidate.[54]

7.1.10 Protecting New York City's Subsurface Water Supply Infrastructure

The advent, in the late 1990s and early 2000s, of geothermal well drilling – also regulated under Article 23 of the ECL if the wells are deeper than 500 feet – led to mutually agreed upon protocols between the Department and the NYCDEP for processing permits to drill in New York City and Delaware, Dutchess, Greene, Orange, Putnam, Rockland, Schoharie, Sullivan, Ulster and Westchester Counties. The Department agreed to notify NYCDEP of any proposed well in the counties outside of New York City, so that NYCDEP could determine if the proposed surface location is within a 1,000-foot wide corridor surrounding a water tunnel or aqueduct. For any well that NYCDEP confirms is outside the corridor, the Department processes the permit application following its normal procedures without any further NYCDEP involvement to address subsurface infrastructure.

[54] Alpha, p. 2-15.

For any well within the 1,000-foot corridor, the Department notifies the applicant that the proposed drilling is an unlisted action and may pose a significant threat to a municipal water supply, necessitating a site-specific SEQRA finding. A negative declaration is only filed upon a demonstration to NYCDEP's satisfaction, through proposed drilling and deviation surveying protocols, that it is feasible to drill at the proposed location with confidence that there will be no impact to tunnels or aqueducts. NYCDEP is provided with a copy of each application for a permit to drill, and any permit issued requires notification to NYCDEP prior to drilling commencement.[55]

Prior to reaching the above-described agreement with NYCDEP, Department staff had considered applying the 660-foot protective buffer for underground mining operations that is provided by the oil and gas regulations to New York City's underground water tunnels and aqueducts.[56] However, those regulations require the underground mine operator (or, in this case, the tunnel operator) to provide detailed location information regarding its underground property rights to the Department. NYCDEP has not provided such maps for the subject counties, and the 1,000-foot protective corridor suggested by NYCDEP was agreeable to Department staff because it is more protective and is consistent with the GEIS criteria for requiring supplemental environmental review for proposed well locations within 1,000 feet of municipal water supply wells.

To prevent impacts to NYC's subsurface water supply infrastructure, Department staff will continue to follow the above protocol for any proposed Article 23 well, including any proposed gas well, in the NYC Watershed. Except for the horizontal drilling and hydraulic fracturing that may occur thousands of feet below the depth of any tunnel or aqueduct, the methods and technologies for geothermal wells are the same as for natural gas wells.

7.1.11 Protecting the Quality of New York City's Drinking Water Supply

New York City's drinking water sources and water supplies are subject to the NYCDEP's Watershed Rules and Regulations and the Delaware River Basin Commission's regulations,

[55]Letter dated April 18, 2007, from Kathleen F. Sanford (Chief, Permits Section, Bureau of Oil & Gas Regulation, NYSDEC Division of Mineral Resources) to Kenneth E. Moriarty, Director, In-House Design, Bureau of Engineering Design & Construction, NYCDEP).

[56] 6 NYCRR 552.4

procedures and programs, in addition to the applicable regulations, policies, and guidelines of the NYSDEC (various divisions), NYSDOH, and USEPA. Local governments and agencies also may exert some control concerning specific activities within their respective jurisdiction, such as road use. The regulations, standards, policies, programs, and procedures of these various federal, state, and local authorities cover a myriad of physical, chemical, and biological aspects that directly and indirectly protect the quantity and quality of the City's drinking water.[57] The web of interrelated regulatory requirements is likely to present significant practical challenges to an operator wishing to engage in high volume hydraulic fracturing within the bounds of the New York City Watershed.

Activities within the NYC watershed that are deemed to potentially affect the City's water supplies require extensive documentation, reviews, and permits, as applicable to the proposed activity. Drilling and high-volume hydraulic fracturing for horizontal shale gas wells is an activity that will be subject to all of the mitigation measures discussed in the GEIS and the Supplement, in addition to requiring approval and compliance with multiple authorities.

Review of the existing authorities relative to both water resources in general and the New York City Watershed in particular indicates that the City's water supply is adequately protected regarding water quality and quantity, and that the possibility of high-volume hydraulic fracturing presents no realistic threat to the Filtration Avoidance Determination. New York City's control of a substantial amount of acreage surrounding the reservoirs through fee ownership or conservation easements provides further protection. Drilling and high-volume hydraulic fracturing cannot occur on such acreage without the City's permission.[58] Similarly, New York State's ownership of land within the New York City watershed, including portions of the Catskill Forest Preserve, provides protection.

Setbacks and procedures proposed in this Supplement, along with supplementary permit conditions for high-volume hydraulic fracturing will provide protection to surface water and ground water statewide. Proposed enhanced procedures and requirements specifically applicable to the New York City Watershed include:

[57] Alpha, p. 4-30

[58] Alpha, p. 4-30

- Prohibition against centralized flowback water surface impoundments within the boundaries of the New York City Watershed (Section 7.1.7),

- Requirement in an unfiltered watershed to remove fluids from any reserve pit or on-site (i.e., well pad) tanks within seven days of completing drilling and stimulation operations at the last well on the pad, or immediately if operations are suspended and the site will be left unattended (Section 7.1.3.2) , and

- Site-specific SEQRA determination for any proposed well pad within 300 feet of a reservoir, reservoir stem or controlled lake[59] or within 150 feet of a watercourse (Section 7.1.12.2).[60]

To the extent practical, operators should place any blending unit with a mixing hopper used for fracturing operations at least 500 feet from reservoir, reservoir stem or controlled lake and 100 feet from a watercourse or state-regulated wetland in the New York City Watershed, in consideration of Section 18-32(b) of NYC's Watershed Rules and Regulations relative to process tanks.

7.1.12 Setbacks

The New York State Department of Health (NYSDOH) recognizes separation distances, or setbacks, as a crucial element of protecting water resources against contamination.[61] While the cited reference pertains specifically to drinking water wells, setbacks also mitigate potential impacts to other water resources. As established in the 1992 GEIS with respect to municipal water supply wells, setback distances can be used to define the level of environmental review and mitigation required for a specific proposed activity.

The proposed setback distances advanced herein reflect consideration of the following information reviewed by Department staff:

- The 1992 GEIS and its Findings.

[59] The terms "reservoir stem" and "controlled lake" are applicable only in the New York City Watershed, as defined by the Watershed Rules and Regulations; see SGEIS Section 2.4.4.3.

[60] The term "watercourse" is applicable only in the New York City Watershed, as defined by the Watershed Rules and Regulations; see SGEIS Section 2.4.4.3.

[61] http://www.health.state.ny.us/environmental/water/drinking/part5/append5b/fs1_additional_measures.htm, viewed 8/26/09

- NYSDOH's required water well separation distances, set forth in Appendix 5-B of the State Sanitary Code.[62] Although sites specifically related to natural gas development and production are not explicitly listed among the potential contaminant sources addressed by Appendix 5-B, DOH staff assisted Department staff in identifying listed sources which are analogous to activities related to high-volume hydraulic fracturing.

- Results and discussion provided by Alpha Environmental Consultants, Inc. (Alpha), to NYSERDA regarding Alpha's survey of regulations related to natural gas development activities in Pennsylvania, Colorado, New Mexico, Wyoming , Texas (including the City of Fort Worth), West Virginia, Louisiana, Ohio and Arkansas.[63]

- Results and discussion provided by Alpha to NYSERDA regarding Alpha's review of the rules and regulations pertaining to protection of water supplies in New York City's Watershed.[64] Again, although natural gas development activities are not specifically addressed, Alpha identified activities which could be considered analogous to aspects of high-volume hydraulic fracturing, including:

    - Hazardous materials storage,
    - Radioactive materials disposal,
    - Storage of petroleum products,
    - Impervious surfaces,
    - Stormwater prevention plans,
    - Miscellaneous point sources, and
    - Solid waste disposal.

- Local watershed rules and regulations for various jurisdictions within the Marcellus and Utica Shale fairways. The counties searched included Broome, Chemung, Chenango, Cortland, Delaware, Madison, Otsego, Steuben, Sullivan, Tioga and Tompkins. Local watershed rules and regulations include setbacks from water supplies related to the following activities which are potentially analogous to aspects of high-volume hydraulic fracturing:

    - Chlorides/salt storage,
    - Burial of storage containers containing toxic chemicals or substances,

[62] http://www.health.state.ny.us/environmental/water/drinking/part5/appendix5b.htm#table1, viewed 8/26/09

[63] Alpha, 2009.

[64] Alpha, 2009.

- Disposal of radioactive materials by burial in soil, and
- Direct discharge of polluted liquid to the ground or a waterbody.

7.1.12.1 Setbacks from Ground Water Resources

The following discussion pertains to the lateral distance, measured at the surface, to a water supply well or spring from one of the following:

- the surface location of the proposed well,
- the closest edge of the well pad, or
- a centralized surface flowback impoundment.

The proposed well and well pad setbacks apply to well permit applications where the target fracturing zone is either at least 2,000 feet deep or 1,000 feet below the underground water supply. These wells would be drilled vertically through the aquifer, so that the aquifer penetration at each well is beneath the well's surface location. Well permit applications where the target fracturing zone is less than either 2,000 feet deep or 1,000 feet below a known underground water supply are addressed in Section 7.1.5.

The EAF addendum for high-volume hydraulic fracturing will require evidence of diligent efforts by the well operator to determine the existence of public or private water wells and domestic-supply springs within half a mile (2,640 feet) of any proposed drilling location. The Department proposes that this distance is adequate to ensure the 2,000-foot SEQRA threshold for public water supply wells is properly applied. The operator will be required to identify the wells and springs, and provide available information about their depth, completed interval and use. Use information will include whether the well is public or private, community or non-community and of what type in terms of the facility or establishment it serves if it is not a residential well. Information sources available to the operator include:

- direct contact with municipal officials,
- direct communication with property owners and tenants,
- communication with adjacent lessees,

- EPA's Safe Drinking Water Act Information System database, available at http://oaspub.epa.gov/enviro/sdw_form_v2.create_page?state_abbr=NY , and

- DEC's Water Well Information search wizard, available at http://www.dec.ny.gov/cfmx/extapps/WaterWell/index.cfm?view=searchByCounty .

Upon receipt of a well permit application, Department staff will compare the operator's well list to internally available information and notify the operator of any discrepancies or additional wells that are indicated within half a mile of the proposed well pad. The operator will be required to amend its EAF Addendum accordingly.

Public Water Supply Wells

The Department's 1992 SEQRA review found that issuance of a permit to drill less than 1,000 feet from a municipal water supply well is considered "always significant" and requires a site-specific Supplemental Environmental Impact Statement (SEIS) dealing with groundwater hydrology, potential impacts and mitigation measures. Any proposed well location between 1,000 and 2,000 feet from a municipal water supply well requires a site-specific assessment and SEQRA determination, and may require a site-specific SEIS. The GEIS provides the discretion to apply the same process to other public water supply wells. The Department is not proposing to alter its 1992 Finding with respect to municipal supply wells, and will continue to exercise its discretion regarding applicability to other public supply wells (i.e., community and non-community water supply system wells) when information is available.

For multi-well pads and high-volume hydraulic fracturing, the site-specific SEQRA process should also consider the adequacy of proposed measures to prevent surface spills and leaks on the well pad that could impact the groundwater supply. However, review of NYSDOH's separation distances in Appendix 5-B of the State Sanitary Code indicates that a 300-foot setback is the largest setback required for any potential contaminant. [65] This is the setback which applies to "chemical storage site(s) not protected from the elements," which could be considered analogous to uncovered pits or surface impoundments which hold flowback water. A 150-foot separation distance is required for "fertilizer and/or pesticide mixing and/or clean up areas," which are comparable to the areas on the well pad used for handling and mixing of frac

[65] http://www.health.state.ny.us/environmental/water/drinking/part5/appendix5b.htm#table1, viewed 8/26/09

additives. Review of local Watershed Rules and Regulations, including New York City's, did not reveal any required setbacks for analogous activities that exceed the 2,000-foot threshold for site-specific review established in 1992 for municipal supply wells. Neither did Alpha's regulatory survey. Because the 2,000-foot threshold so greatly exceeds the NYSDOH-required setback distances for analogous activities that could occur on the pad, measuring the distance to the public supply well from the proposed surface location of the well itself (instead of from the edge of the well pad) is sufficiently protective with respect to potential spills or leaks on the well pad.

Centralized flowback water surface impoundments will be designed specifically to prevent groundwater infiltration, will be equipped with leak detection and groundwater monitoring systems, and do not involve the potential for undetected wellbore-to-wellbore contamination. Therefore, any setback from a public water supply well is based primarily on a concern about surface spills. In light of the above discussion about NYSDOH's separation distances for the analogous activity of "chemical storage site(s) not protected from the elements," the Department proposes that site-specific SEQRA review be required for the following project:

1) any proposed centralized flowback water surface impoundment within 300 feet of a public water supply well.

Areas where the Department proposes to disallow centralized flowback surface impoundment are listed in Section 7.7. The above proposed setback would apply outside those areas.

Private Water Wells and Domestic Supply Springs

Chapter 6 describes potential impacts related to high-volume hydraulic fracturing that may require enhanced protections for private water wells and domestic-supply springs. These concerns stem more from handling greater fluid volumes on the surface than from downhole activities. Fluid and chemicals could be present and handled anywhere on the well pad. Setbacks, therefore, should be measured from the edge of the well pad.

As stated above, pits or open surface impoundments that could contain flowback water are analogous to "chemical storage site(s) not protected from the elements," which are subject to a

300-foot separation distance from water wells under Appendix 5-B of the State Sanitary Code.[66] Flowback water tanks and additive containers could be compared to "chemical storage site(s) protected from the elements," which require a 100 foot setback from water wells.[67] Handling and mixing of frac additives onsite is comparable to "fertilizer and/or pesticide mixing and/or clean up areas," which require a 150 foot distance from water wells.[68]

Based on these existing DOH-established separation distances, the Department proposes that site-specific SEQRA review be required for the following high-volume hydraulic fracturing projects:

1) any proposed well pad within 150 feet of a private water well or domestic-supply spring, and

2) any proposed centralized surface flowback impoundment within 300 feet of a private water well or domestic-use spring.

Areas where the Department proposes to disallow centralized flowback impoundment are listed in Section 7.7. The above proposed setback would apply outside those areas.

7.1.12.2 Setbacks from Surface Water Resources

Application of setbacks from surface water resources prevents direct flow of the full, undiluted volume of a spilled contaminant into a surface water body. Some amount of soil adsorption or evaporation would occur in the event of a spill. Existing regulations prohibit the surface location of an oil or gas well within 50 feet of any "public stream, river or other body of water."[69] The 1992 GEIS proposed that this distance be increased to 150 feet and apply to the entire well site instead of just the well itself.

Significant surface spills at well pads which could contaminate surface water bodies, including municipal supplies, are most likely to occur during activities which are closely observed and controlled by personnel at the site. More people are present to monitor operations at the site

[66] http://www.health.state.ny.us/environmental/water/drinking/part5/appendix5b.htm#table1, viewed 8/26/09

[67] http://www.health.state.ny.us/environmental/water/drinking/part5/appendix5b.htm#table1, viewed 8/26/09

[68] http://www.health.state.ny.us/environmental/water/drinking/part5/appendix5b.htm#table1, viewed 8/26/09

[69] 6 NYCRR Part 553.2

during high-volume hydraulic fracturing and flowback operations than at any other time period in the life of the well pad. Therefore, any surface spills during these operations are likely to be quickly detected and addressed rather than continue undetected for a lengthy time period. Other factors which mitigate the risk of surface water contamination resulting from well pad operations include the following:

- Required multi-sector industrial stormwater permit coverage, including a Stormwater Pollution Prevention Plan (SWPPP).
- Supplementary Permit Conditions for High-Volume Hydraulic Fracturing (see Appendix 10) , which are proposed to include:
    - Pit construction and liner specifications for well pad reserve pits;
    - Requirement that tanks be used to contain flowback water on site;
    - Appropriate secondary containment measures;
    - Use of appropriate pressure-control procedures and equipment, including blow-out prevention equipment that is tested on-site prior to drilling ahead and fracturing equipment that is pressure tested with fresh water ahead of pumping fracturing fluid; and
    - Pre-fracturing pressure testing of casing from surface to top of treatment interval.
- SGEIS setbacks related to potential surface activities measured from the edge of the well pad instead of from the well. Municipal ownership of land surrounding municipal surface water supplies may provide additional protection if the municipal-owned buffer exceeds the setback distance. Other waterfront owners may decline to lease or offer only non-surface entry leases [e.g., Otsego Lake owners around the lake include NYS (Glimmerglass State Park), Clark Foundation, etc.]
- Proposed requirement for closed-loop drilling in floodplains.
- The Department's existing requirement for a Freshwater Wetlands Permit in wetland or 100-foot buffer zone.

With respect to surface municipal supplies, the GEIS found that a 150-foot distance between the wellsite and a surface water supply would provide adequate protection in the event of an accidental spill. Required erosion and sedimentation control plans would address potential impacts to nearby waterbodies from ground disturbance. (As discussed elsewhere in this

document, the Department has since determined that stormwater permit coverage is required for disturbance greater than one acre.)

Reservoir setbacks for comparable activities in the NYC Watershed Rules and Regulations range between 300 and 500 feet.[70] Other local Watershed Rules and Regulations establish various setbacks between 20 and 1,000 feet, but they generally pertain either to actual burial of materials for disposal purposes or direct discharges to the ground or surface waterbodies. Burial or direct discharges to the ground of fracturing fluid, additive chemicals or flowback water are not proposed and would not be approved. The only on-site burial discussed in Chapter 5 of this document pertains to uncontaminated cuttings and pit-liners associated with air or fresh-water drilling, as allowed under the 1992 GEIS. Direct discharges to surface water bodies are regulated by the Department's SPDES permitting program.

The required setbacks from surface water supplies in other states reviewed by Alpha vary between 100 and 350 feet.[71] Colorado's new Public Water System Protection rule requires a variance for surface activity, including drilling, completion, production and storage, within 300 feet of a surface public water supply.[72]

Many local Watershed Rules and Regulations, including New York City's, require smaller setbacks from watercourses, as specifically defined within the watershed (see Section 2.4.4.3) than from reservoirs.

Based on the above information and mitigating factors, the Department proposes that site-specific SEQRA review be required for the following projects:

- any proposed well pad within 300 feet of a reservoir, reservoir stem or controlled lake; [73]
- any proposed well pad within 150 feet of a watercourse,[74] perennial or intermittent stream, storm drain, lake or pond;

[70] Alpha, 2009.

[71] Alpha, 2009.

[72] http://cogcc.state.co.us/RR_Docs_new/rules/300series.pdf, viewed 8/26/09

[73] The terms "reservoir stem" and "controlled lake" are applicable only in the New York City Watershed, as defined by the Watershed Rules and Regulations; see SGEIS Section 2.4.4.3.

- any proposed centralized flowback water impoundment within 1,000 feet of a reservoir; and

- any proposed centralized flowback water surface impoundment within 500 feet of a perennial or intermittent stream, wetland, storm drain, lake or pond.

Greater setback distances are proposed for centralized flowback water surface impoundments than for well pads for the reasons described in Section 7.7. Areas where the Department proposes to disallow centralized flowback surface impoundments are also listed in Section 7.7. The above proposed setbacks would apply outside those areas.

7.2 Protecting Floodplains

As detailed in Section 2.4.9, nearly all communities in New York with identified flood hazard areas participate in the National Flood Insurance Program (NFIP). The NFIP requires that a floodplain development permit issued by the local government be obtained before commencing any floodplain development activity.

The EAF Addendum will require the applicant to confirm that Flood Insurance Rate Maps and, if applicable, Flood Boundary and Floodway maps are checked to identify whether a proposed well pad is in a 100-year floodplain and a floodway.

Supplementary permit conditions for high-volume hydraulic fracturing will require that if a local floodplain development permit is necessary, a copy must be provided to the Department prior to any site disturbance. Because of the length of time that activity may continue at a multi-well pad, a closed-loop tank system will be required instead of a reserve pit for managing fluids and cuttings. Additional comprehensive guidelines relative to site construction in flood-prone areas are presented in Chapter 8 of the GEIS.

With respect to fluid disposal plans required under 6 NYCRR 554.1(c)(1), centralized flowback water surface impoundments will not be approved in 100-year floodplains, nor will above-ground flowback water piping and conveyances.

[74] The term “watercourse” is applicable only in the New York City Watershed, as defined by the Watershed Rules and Regulations; see SGEIS Section 2.4.4.3.

7.3 Protecting Freshwater Wetlands

Section 2.4.10 summarizes the State's Freshwater Wetlands regulatory program, which addresses activities within 100 feet of regulated wetlands. In addition, the federal government regulates development activities in wetlands under Section 404 of the Clean Water Act.

The Department found in 1992 that issuance of a well permit when another Department permit is necessary requires a site-specific SEQRA determination relative to the activities or resources addressed by the other permit. In such instances, which include Freshwater Wetlands Permits, the well permit is not issued until the SEQRA process is complete and the other permit is issued.

Mitigation measures for avoiding wetland impacts from well development activities are described in Chapter 8 of the GEIS, which provides that well permits are issued for locations in wetlands only when alternate locations are not available. Potential mitigation measures are not limited to those discussed in the GEIS, but may include other alternatives recommended by Fish, Wildlife and Marine Resources staff based on current techniques and practices. Additional measures proposed in this Supplement include the following:

- Requirement that, to the extent practical, fuel tanks for drilling rigs not be placed within 500 feet of a wetland (Section 7.1.3.1) ;

- Requirement for secondary containment consistent with the Department's SPOTS 10 for any drilling rig's fuel tank, regardless of size, that is placed within 500 feet of a wetland (Section 7.1.3.1); and

- Requirement for a site-specific SEQRA determination for any fluid disposal plan submitted pursuant to 6 NYCRR 554.1(c)(1) that includes a centralized flowback water surface impoundment within 500 feet of a regulated wetland (Section 7.1.12.2).

7.4 Protecting Ecosystems and Wildlife

Water withdrawal, invasive species concerns, and use of centralized flowback water surface impoundments are indentified in Chapter 6 as the ecosystem and wildlife concerns specifically related to high-volume hydraulic fracturing that are not addressed by the GEIS. Mitigation of the potential adverse impacts of water withdrawal is discussed in Section 7.1.1. The following text addresses invasive species and use of centralized flowback water surface impoundments.

7.4.1 Invasive Species

Chapter 26 of the Laws of New York, 2008, amended the Environmental Conservation Law (ECL) to create the New York Invasive Species Council[75,76] and define the DEC's authority regarding control of invasive species in New York. The Council, co-lead by the DEC and the Department of Agriculture and Markets (DAM), comprises the Department of Transportation (DOT), the Office of Parks, Recreation and Historic Preservation (OPRHP), the State Education Department (SED), the Department of State (DOS), the Thruway Authority, the New York State Canal Corporation, and the Adirondack Park Agency (APA).

The role of the Council includes identifying actions to prevent the introduction of invasive species, detect and respond rapidly to control populations of invasive species, monitor invasive species populations, provide for the restoration of native species and habitats that have been invaded, and promote public education on invasive species. [77]

Additionally, a comprehensive management plan is being developed which will address all taxa of invasive species in New York, with an emphasis on prevention, early detection and rapid response, and opportunities for control and restoration to prevent future damage. In accordance with ECL §9-1705(5)(c), the plan will incorporate the approved New York State Aquatic Nuisance Species Management Plan, the Lake Champlain Basin Aquatic Nuisance Species Management Plan, and the Adirondack Park Aquatic Nuisance Species Management Plan.

The Council will also submit to the legislature and governor a report recommending a four-tier system for non-native animal and plant species. The system will contain proposed lists of prohibited, regulated and unregulated species, and a procedure for the review of any non-native species that is not on the aforementioned lists before the use, distribution or release of such non-native species.

---

[75] ECL § 9-1707

[76] The New York Invasive Species Council supplanted the Invasive Species Task Force that was established in 2003 to explore the invasive species issue and provide recommendations to the Governor and Legislature by November 2005. The task force's findings and recommendations are summarized in the "Final Report of the New York State Invasive Species Task Force," which is available at http://www.dec.ny.gov/docs/wildlife_pdf/istfreport1105.pdf.

[77] ECL §9-1705(5)(b)

While the Council is currently developing a comprehensive invasive species management plan and the four-tier system previously discussed, ECL §9-1709(2)(d) authorizes the Department to prohibit and actively eliminate invasive species at project sites regulated by the State. This responsibility falls within the purview of the Department's Division of Fish, Wildlife and Marine Resources.

7.4.1.1 Terrestrial

In order to mitigate the potential transfer of terrestrial invasive species from project locations associated with high-volume hydraulic fracturing, including well pads, access roads, and engineered impoundments for fresh water and flowback water storage, well operators will be required to conduct all activities in accordance with the best management practices below. This requirement will be reflected by a permit condition which will be included on all well permits where high-volume hydraulic fracturing is proposed.

Survey for the Presence of Invasive Species

Invasive species control is two-fold in that it involves both limiting the spread of existing invasive species and limiting the introduction of new invasive species. In order to accomplish these objectives, it is necessary to identify the types of invasive species which are present at a project site as well as map the locations and extent of any established population.

Therefore, the Department will require that well operators submit, with the EAF Addendum, a comprehensive survey of the entire project site, documenting the presence and identity of any invasive plant species. This survey will establish a baseline measure of percent aerial coverage and, at a minimum, must include the plant species identified on the Interim List of Invasive Plant Species in New York State[78]. A map (1:24,000) showing all occurrences of invasive species within the project site must be produced and included with the survey as part of the EAF Addendum.

Field notes, photographs and GPS handheld equipment should be utilized in documenting any occurrences of invasive species and all such occurrences must be clearly identified in the field with signs, flagging, and/or stakes prior to any ground disturbance. Supplementary permit

[78] This list appears in Tables 6.4 and 6.5.

conditions for high-volume hydraulic fracturing will specify that if the invasive species survey submitted with the EAF Addendum shows the presence of invasive species in the topsoil, consultation with the Department's Division of Fish, Wildlife and Marine Resources is required prior to any ground disturbance.

Preventing the Spread of Invasive Species

- Prior to any ground disturbance, any invasive plant species encountered at the site should be stripped and removed. Cut plant materials should be placed in heavy duty, 3 mil or thicker, black, contractor quality plastic cleanup bags. The bags should then be securely tied and transported from the site to a proper disposal facility in a truck with a topper or cap, in order to prevent the spread or loss of the plant material during transport.

- Cut invasive plant species materials should not be disposed of into native cover areas.

- Machinery and equipment, including hand tools, used in invasive species affected areas must be pressure-washed and cleaned with water (no soaps or chemicals) prior to leaving the invasive species affected area to prevent the spread of seeds, roots or other viable plant parts. This includes all machinery, equipment and tools used in the stripping, removal, and disposal of invasive plant species.

- Equipment or machinery shall not be washed in any waterbody or wetland, and run-off resulting from washing operations should not be allowed to directly enter any waterbodies or wetlands.

- Loose plant and soil material that has been removed from clothing, boots and equipment, or generated from cleaning operations shall either be a) rendered incapable of any growth or reproduction or b) appropriately disposed of off-site. If disposed of off-site, the plant and soil material shall be transported in a secure manner.

Preventing New Invasive Species Introductions

- All machinery and equipment to be used in the construction of the proposed project, including but not limited to trucks, tractors, excavators, and any hand tools, must be washed with high pressure hoses and hot water prior to delivery to the project site to insure that they are free of invasive species.

- All fill and/or construction material (e.g. gravel, crushed stone, top soil, etc.) from offsite locations should be inspected for invasive species and should only be utilized if no invasive species are found growing in or adjacent to the fill/material source.

- Only certified weed-free straw should be utilized for erosion control.

Restoration and Preservation of Native Vegetation

- Native vegetation should be reestablished and weed-free mulch should be used on bare surfaces to minimize weed germination.

- Only native (non-invasive) seeds or plant material should be used for re-vegetation during site reclamation. An appropriate native seed mixture should be selected based on pre-disturbance surveys.

- All seed should be from local sources to the extent possible and should be applied at the recommended rates to ensure adequate vegetative cover to prevent the colonization of invasive species.

- As part of site reclamation, re-vegetation should occur as quickly as possible at each project site.

- Any top soil brought to the site for reclamation activities must be obtained from a source known to be free of invasive species.

- The site should be monitored for new occurrences of invasive plant species following partial reclamation. If new occurrences are observed, they should be treated with appropriate physical or chemical controls.

General

- Implementation of the above practices must be in accordance with a site-specific and species-specific invasive species mitigation plan that includes seasonally appropriate specific physical and chemical control methods (e.g., digging to remove all roots, cutting to the ground, applying herbicides to specific plant parts such as stems or foliage, etc.). The invasive species mitigation plan must be available to the Department upon request and available on-site for a Department inspector's review at any time that related activities are occurring.

- The well operator should assign an environmental monitor to check that all trucks, machinery and equipment have been washed prior to entry and exit of the project site and that there is no dirt or plant material clinging to the wheels, tracks, or undercarriage of the vehicles or equipment.

- Any new invasive species occurrences found at the project location should be removed and disposed of appropriately.

7.4.1.2 Aquatic[79]

It is beneficial to the operators to implement water conservation and recycling practices because of the potential difficulties obtaining the large volumes of water needed for hydraulic fracturing. Most or all operators will recycle or reuse flowback water to reduce the need for fresh water.

It is possible that some unused fresh water may remain in a surface impoundment after drilling and hydraulic fracturing is completed. This is likely in circumstances where operators build large centralized surface impoundments to hold water for all drilling and hydraulic fracturing operations within a several mile radius. Unused water may be transported by truck or pipeline and discharged into tanks or surface impoundments for use at another drilling location. It also is possible that unused water could be transported and discharged at its point of origin with proper approval. Either of these options avoids the transfer of invasive species into a new habitat or watershed. Precautions must be implemented, especially when water is stored in surface impoundments, to preclude the transfer of invasive species into new habitats or watersheds.

Unused fresh water also could be transported to a wastewater treatment facility for processing, although this is considered unlikely given the anticipated demand for water in the drilling and hydraulic fracturing process. As detailed in Section 7.1.8.1, flowback water cannot be taken to a publicly owned treatment works without the Department's approval. Standard treatment processes at waste water treatment plants, such as dissolved air flotation, have been shown to successfully remove biological particles and sediments that might harbor invasive species; however, the safest method to avoid transfer of invasive species is to not transfer water from one waterbody to another.

Regulatory protections exist to mitigate the potential transfer of invasive species. Regulations and policies of SRBC and DRBC both address the transfer, reuse and discharge of water and have specific provisions to prevent transfer of invasive species. Table 7.3 is a matrix of SRBC and DRBC regulations pertaining to transfer of invasive species. The regulations are identified that specifically address the transport of invasive or nuisance aquatic species. Other regulations in Table 7.3 do not specifically relate to invasive species, but the required actions and policies nonetheless may have the effect of reducing or eliminating their transport.

[79] Text provided by Alpha, p. 3-6 *et seq.*, and supplemented by DEC

The SRBC's policy is to discourage the diversion or transfer of water from the basin with the objective of conserving and protecting water resources. Additionally, the SRBC specifically requires that "any unused (surplus) water shall not be discharged back to the waters of the basin without appropriate controls and treatment to prevent the spread of aquatic nuisance species."

The DRBC controls both exportation and importation of water from the Delaware River Basin. The DRBC's Rules of Practice and Procedure state that a project sponsor (e.g., operator) may not discharge to surface waters of the basin or otherwise undertake the project (gas well) until the sponsor has applied for, and received, approval from the commission. Flow-back water cannot be taken to a publicly owned treatment works within the Delaware River Basin without the approval of the DRBC. DRBC also prohibits discharge to the waters of the basin without prior approval. These actions and policies effectively control the use, withdrawal, discharge, and transfer to water from and into the basin and reduce the potential for transfer of invasive aquatic species.

The measures and protocols adopted by the SRBC and DRBC appear to be sufficient to address the potential for transfer of invasive species associated with water use for high-volume hydraulic fracturing. To the extent that operators seek to obtain, transport, use, and discharge water outside the jurisdictional boundaries of SRBC and DRBC, the NYSDEC may consider requiring equivalent mitigation measures for both large-scale basins and at smaller scales to avoid invasive species transfer.

7.4.2 Centralized Flowback Water Surface Impoundments

Impoundments should be constructed to be unattractive to wildlife. The inside slopes that could come into contact with fluctuating flowback water levels should be kept clear of vegetation. The impoundment must be fenced and to prevent access by larger species of wildlife. In addition, installation of netting should be considered as an additional measure to prevent wildlife from using the impoundment.

TABLE 7.3
Summary of Regulations Pertaining to Transfer of Invasive Species

Agency	Document	Article	Regulation Summary
SRBC	Federal Register, Vol 73, No. 247, Rules and Regulations	18 CFR Part 806.22,f,8	All flowback and produced fluids, including brines, must be treated and disposed of in accordance with applicable state and federal law.
SRBC	Regulation of Projects	18 CFR Part 806.24,b,3,c	For diversions into the SRB, must provide: (1) the source, amount, and location of the diverted water,and (2) the water quality classification, if any, of the SRBC discharge stream and the discharge location(s). (3) All applicable withdrawal or discharge permits or approvals must have been applied for or received, and must prove that the diversion will not result in water quality degradation that may be injurious to any existing or potential ground or surface water use.
SRBC	Regulation of Projects	18 CFR Part 801.3,b	The SRBC will require evidence that proposed interbasin transfers of water will not jeopardize, impair or limit the efficient development and management of the SRBC's water resources, or any aspects of these resources for in-basin use, or have a significant unfavorable impact on the resources of the basin and the receiving waters of the Chesapeake Bay.
SRBC	Regulation of Projects	18 CFR Part 801.3,c,1	Allocations, diversions, or withdrawals of water must be based on (1) the rights of landholders in any watershed to use the stream water in reasonable amounts and to have the stream flow not unreasonably diminished in quality or quantity by upstream use or diversion of water; and (2) on the maintenance of the historic seasional variations of the flows into Chesapeake Bay.
SRBC	Regulation of Projects	18 CFR Part 806.23,2	The SRBC may deny or limit an approval if a withdrawal may cause significant adverse impacts to SRB water, including: lowering of groundwater or stream flow levels; rendering competing supplies unreliable; affecting other water uses; causing water quality degradation that may be injurious to any existing or potential water use; affecting any living resources or their habitat; causing permanent loss of aquifer storage capacity; or affecting low flow of perennial or intermittent streams.
SRBC	Federal Register, Vol 73, No. 247, Rules and Regulations	18 CFR Part 806.22,f,6	Flowback fluids or produced brines used for hydrofracturing must be separately accounted for, but will not be included in the daily use volume or be subject to the mitigation requirements of § 806.22 [b].
SRBC	Standard Docket Conditions Contained In Gas Well **Consumptive Water Use**	* Item 10.	Unused water shall not be discharged back to the SRB waters without appropriate controls and treatment to prevent the spread of aquatic nuisance species.
SRBC	Regulation of Projects	18 CFR Part 806.25,b, 4	Industrial water users must evaluate and utilize applicable recirculation and reuse practices.
SRBC	Standard Docket Conditions Contained In Gas Well **Surface Water** Dockets	Item 4. (Not contained in all approvals)	Within ninety (90) days of this approval, the project sponsor shall submit a plan of study and a schedule for completion to conduct a survey and evaluate the potential impacts on the rare and protected freshwater mussels located in the Susquehanna River within the area of the withdrawal.
SRBC	Standard Docket Conditions Contained In Gas Well **Surface Water** Dockets	Item 5. (Not contained in all approvals)	This approval does not become effective until the SRBC is satisfied that the withdrawal has no adverse impacts to the rare and protected freshwater mussel species of concern.
SRBC	Standard Docket Conditions Contained In Gas Well **Surface Water** Dockets	* Item 10.	Must report the method of water transport (tanker truck or pipeline) and show that all water withdrawn from surface water sources is transported, stored, injected into a well, or discharged with appropriate controls and treatment to prevent the spread of aquatic nuisance species.
DRBC	Water Code 18 CFR Part 410	2.20.2	The underground water-bearing formations of the DRB, their waters, storage capacity, recharge areas, and ability to convey water shall be preserved and protected.
DRBC	Water Code 18 CFR Part 410	2.20.3	Projects that withdraw underground waters must reasonably safeguard the present and future public interest in the affected water resources.
DRBC	Water Code 18 CFR Part 410	2.20.4	Withdrawals from DRB ground water are limited to the maximum draft of all withdrawals from a ground water basin, aquifer, or aquifer system that can be sustained without rendering supplies unreliable, causing long-term progressive lowering of ground water levels, water quality degradation, permanent loss of storage capacity, or substantial impact on low flows of perennial streams, unless the DRBC decides a withdrawal is in the public interest. In confined coastal plain aquifers, the DRBC may apply aquifer management levels, if any, established by a signatory state in determining compliance with criteria relating to "longterm progressive lowering of ground water levels."
DRBC	Water Code 18 CFR Part 410	2.20.5	The principal natural recharge areas of the DRB shall be protected from unreasonable interference. No recharge sources (ground or surface water) shall be polluted based on water quality standards promulgated by the DRBC or any of the signatory parties.
DRBC	Water Code 18 CFR Part 410	2.20.6	The DRB ground water resources shall be used, conserved, developed, managed, and controlled for the needs of present and future generations, so interference, impairment, penetration, or artificial recharge shall be subject to review and evaluation under the Compact.
DRBC	Water Code 18 CFR Part 410	2.10.1	The DRBC may acquire, operate and control projects and facilities for the storage and release of waters, for the regulation of flows and DRB surface and ground water supplies, for the protection of public health, stream quality control, economic development, improvement of fisheries, recreation, pollution dilution and abatement, the prevention of undue salinity and other purposes. No signatory party may permit any augmentation of flow to be diminished by the diversion of any DRB water during any period in which waters are being released from storage by the DRBC for the purpose of augmenting such flow, except in cases where such diversion is authorized by this compact, or by the DRBC pursuant to, or by the order of a court of competent jurisdiction.

Agency	Document	Article	Regulation Summary
DRBC	Water Code 18 CFR Part 410	2.30.2	The waters of the DRB are limited in quantity and to drought. The exportation of DRB water is discouraged. The DRB waters have limited assimilative capacity to accept substances without significant impacts. Wastewater import that would significantly reduce the assimilative capacity of the receiving DRB stream is discouraged and should be reserved for users within the DRB.
DRBC	Water Code 18 CFR Part 410	2.30.3	Consideration of the importation or exportation of water will be conducted pursuant to this policy and include assessments of the water resource and economic impacts of the project and of all alternatives to any water exportation or wastewater importation project.
DRBC	Water Code 18 CFR Part 410	2.30.4	The DRBC has jurisdiction over exportations and importations of water (Section 3.8 of the Compact, and inclusion within the Comprehensive Plan) as specified in the Administrative Manual - Rules of Practice and Procedure. The applicant shall address those of the items listed below as directed by the DRBC: A. efforts to develop or use and conserve outside resources; B. water resource, economic, and social impacts of each alternative, including the "no project" alternative; D. amount, timing and duration of the proposed transfer and its relationship to DRB hydrologic conditions, and impact on instream uses and downstream waste assimilation capacity; E. benefits to the DRB as a result of the proposed transfer; F. volume of the transfer and its relationship to other specified actions or Resolutions by the DRBC; G. the relationship of the transfer volume to all other diversions; H. other significant benefits or impairments to the DRB as a result of the proposed transfer.
DRBC	Water Code 18 CFR Part 410	2.30.6	The DRBC gives no credit toward meeting wastewater treatment requirements for wastewater imported into the Delaware Basin. Wasteload allocations assigned to dischargers will not include loadings attributable to wastewater importation.
DRBC	Water Code 18 CFR Part 410	2.200.1	DRB water quality will be maintained in a safe and satisfactory condition for...wildlife, fish and other aquatic life.
DRBC	Water Code 18 CFR Part 410	2.350.2	The DRBC will preserve and protect wetlands by: A. minimizing adverse alterations in the quantity and quality of the underlying soils and natural flow of waters that nourish wetlands; B. safeguarding against adverse draining, dredging or filling practices, liquid or solid waste management practices, and siltation; C. preventing the excessive addition of pesticides, salts or toxic materials arising from non-point source wastes; and D. preventing destructive construction activities.
DRBC	Water Code 18 CFR Part 410	2.400.2	The drought of record, which occurred in the period 1961-1967, shall be the basis for planning and development of facilities and programs for control of salinity in the Delaware Estuary.
DRBC	Water Code 18 CFR Part 410	3.10.3,A,1	The DRBC maintains the quality of interstate waters, where existing quality is better than the established stream quality objectives, unless such change is justifiable as a result of necessary economic or social development or to improve significantly another body of water. The DRBC will require the highest degree of waste treatment practicable. No change will be considered which would be injurious to any designated present or future use.
DRBC	Water Code 18 CFR Part 410	3.10.3,A,2,b	There will be no measurable change in water quality except towards natural conditions in water that has high scenic, recreational, ecological, and/or water supply values. Waters with exceptional values may be classified as either **Outstanding Basin Waters (OBW) or Significant Resource Waters (SRW)**. OBW shall be maintained at their existing water quality. 2) SRW must not be degraded below existing water quality, although localized degradation of water quality may be allowed for initial dilution if the DRBC, after consultation with the state NPDES permitting agency, finds that the public interest warrants these changes, unless a mixing zone is allowed and then to the exten of the mixing zone designated as set forth in this section. If degradation of water quality is allowed for initial dilution purposes, the DRBC, will designate mixing zones for each point source and require the highest possible point source treatment levels necessary to limit the size and extent of the mixing zones. The dimensions of the mixing zone will be based upon an evaluation of (a) site specific conditions, including channel characteristics; (b) the cost and feasibility of treatment technologies; and (c) the design of the dis
DRBC	Water Code 18 CFR Part 410	3.10.3,A,2,c	1) Direct discharges of wastewater to **Special Protection Waters (SPW)** are discouraged. New wastewater treatment facilities and substantial alterations to existing facilities that discharge directly to SPW may be approved after the applicant has evaluated all nondischarge/ load reduction alternatives and is unable to implement these alternatives because of technical and/or financial infeasibility. 2) New wastewater treatment facilities and substantial alterations to existing facilities within the drainage area of SPW may be approved after the applicant fully evaluated all natural treatment alternatives and is unable to implement them because of technical and/or financial infeasibility. **For both 1) and 2)** above, the applicant will consider alternatives to all loadings – both existing and proposed – in excess of actual loadings at the time of SPW designation. 3) New wastewater treatment facilities and substantial alterations to existing facilities discharging directly to SRW may be approved only following a determination that the project is in the public interest as that term is defined in Section 3.10.3.A.2.a.5 4) The general number, location and size of future wastewater treatment facilities discharging to OBW (if an
DRBC	Water Code 18 CFR Part 410	3.10.3,A,2,d	Addresses emergency systems (standby power facilities, alarms, emergency management plans) for wastewater treatment facilities discharging to SPW. Emergency management plans shall include an emergency notification procedure covering all affected downstream users. The minimum level of wastewater treatment for new wastewate treatment facilities and substantial alterations to existing wastewater treatment facilities that discharge directly to OBW or SRW will be **Best Demonstrable Technology (BDT)** (See rule for chemical analyses results that define BDT.) BDT may be superseded by applicable federal, state or DRBC criteria that are more stringent. BDT for disinfection - ultraviolet light disinfection or an equivalent disinfection process that results in no harm to aquatic life, does not produce toxic chemical residuals, and results in effective bacterial and viral destruction. DRBC may approve effluent trading on a voluntary basis between point sources within the same watershed or between the same Interstate or Boundary Control Points to achieve no measurable change to existing water quality. Regulation discusses facilities within drainage areas of SPW and discharges to OBW and SRW and lists water quality control points and the analyses parameters.
DRBC	Water Code 18 CFR Part 410	3.10.3,A,2,e	1) Projects subject to review under Section 3.8 of the Compact that are located in the drainage area of SPW must submit for approval a Non-Point Source Pollution Control Plan that controls the new or increased non-point source loads generated within the portion of the project's service area which is also located within the drainage area of SPW The plan will state which BMPs must be used to control the non-point source loads. RULE DISCUSSES trade-off plans in detail. It discusses: projects located above major

Agency	Document	Article	Regulation Summary
			surface water impoundments; projects located in municipalities that have adopted and are actively implementing non-point source/stormwater control ordinances, projects located in watersheds where the applicable state environmental agency, county government, and local municipalities are participating in the development of a watershed plan. 2) Approval of a new or expanded water withdrawal and/or wastewater discharge project will be subject to the condition that any new connection to the project system only serve an area(s) regulated by a non-point source pollution control plan which has been approved by the DRBC. 3) Future plans for SPWs non-point source control regulations
DRBC	Water Code 18 CFR Part 410	3.10.3B	DRB waters will not contain substances attributable to municipal, industrial, or other discharges in concentrations or amounts sufficient to preclude the protection of specified water uses. a. The waters shall be substantially free from unsightly or malodorous nuisances due to floating solids, sludge deposits, debris, oil, scum, substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life, or that produce color, taste, odor of the water, or taint fish or shellfish flesh. b. The concentration of total dissolved solids, except intermittent streams, shall not exceed 133 percent of background. In no case shall concentrations of substances exceed those values given for rejection of water supplies in the United States Public Health Service Drinking Water Standards.
DRBC	Water Code 18 CFR Part 410	3.10.3C	The DRBC designates numerical stream quality objectives for the protection of aquatic life for the Delaware River Estuary (Zones 2 through 5) which correspond to the designated uses of each zone. Aquatic life objectives for the protection from both acute and chronic effects are herein established on a pollutant-specific basis. (See RULE)
DRBC	Water Code 18 CFR Part 410	3.10.3D	The DRBC designates numerical stream quality objectives for the protection of human health for the Delaware River Estuary (Zones 2 through 5) which correspond to the designated uses of each zone. Stream quality objectives for protection from both carcinogenic and systemic effects are herein established on a pollutant-specific basis. (See RULE)
DRBC	Water Code 18 CFR Part 410	3.10.4,A	All wastes shall receive a minimum of secondary treatment, regardless of the stated stream quality objective.
DRBC	Water Code 18 CFR Part 410	3.10.4,B	Wastes (exclusive of stormwater bypass) containing human excreta or disease producing organisms shall be effectively disinfected before being discharged into surface bodies of water as needed to meet applicable DRBC or State water quality standards.
DRBC	Water Code 18 CFR Part 410	3.10.4,C	Effluents shall not create a menace to public health or safety at the point of discharge.
DRBC	Water Code 18 CFR Part 410	3.10.4,D	Lists discharge contaminant limits.
DRBC	Water Code 18 CFR Part 410	3.10.4,E	Where necessary to meet the stream quality objectives, the waste assimilative capacity of the receiving waters shall be allocated in accordance with the doctrine of equitable apportionment.
DRBC	Water Code 18 CFR Part 410	3.10.4,F	1. Discharges to intermittent streams may be permitted by the DRBC only if the applicant can demonstrate that there is no reasonable economical alternative, the project is environmentally acceptable, and would not violate the stream quality objectives set forth in Section 3.10.3B.1.a. 2. Discharges to intermittent streams shall be adequately treated to protect stream uses, public health and ground water quality, and prevent nuisance conditions.
DRBC	Water Code 18 CFR Part 410	3.10.5,E	The DRBC will consider requests to modify the stream quality objectives for toxic pollutants based upon site-specific factors. Such requests shall provide a demonstration of the site-specific differences in the physical, chemical or biological characteristics of the area in question, through the submission of substantial scientific data and analysis. The demonstration shall also include the proposed alternate stream quality objectives. The methodology and form of the demonstration shall be approved by the DRBC.
NYSDEC	6 NYCRR Part 608	608.9	(a) Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section). Any applicant for a federal license or permit to conduct any activity, including but not limited to the construction or operation of facilities that may result in any discharge into navigable waters as defined in Section 502 of the Federal Water Pollution Control Act (33 USC 1362), must apply for and obtain a water quality certification from the department.The applicant must demonstrate compliance with Sections 301-303, 306 and 307 of the Federal Water Pollution Control Act (See RULE.)

* Connotes the indicated regulation pertains directly to invasive or nuisance species. All other regulations reference practices, methods, and actions that are not specifically targeted at reducing or eliminating the transport of invasive species, but nonetheless may indirectly address the issue.

7.5 Protecting Air Quality

7.5.1 Mitigation Measures Resulting from Regulatory Analysis (Internal Combustion Engines and Glycol Dehydrators)

7.5.1.1 NOx

Control Technologies for Natural Gas Engines

Three generic control techniques have been developed for reciprocating engines: parametric controls (timing and operating at a leaner air-to-fuel ratio); combustion modifications such as advanced engine design for new sources or major modification to existing sources (clean-burn cylinder head designs and pre-stratified charge combustion for rich-burn engines); and post-combustion catalytic controls installed on the engine exhaust system. Post-combustion catalytic technologies include selective catalytic reduction (SCR) for lean-burn engines, nonselective catalytic reduction (NSCR) for rich-burn engines, and CO oxidation catalysts for lean-burn engines.

CONTROL TECHNIQUES FOR 4-CYCLE RICH-BURN ENGINES

Nonselective Catalytic Reduction (NSCR) - This technique uses the residual hydrocarbons and CO in the rich-burn engine exhaust as a reducing agent for NO_x. In an NSCR, hydrocarbons and CO are oxidized by O_2 and NO_x. The excess hydrocarbons, CO and NO_x pass over a catalyst (usually a noble metal such as platinum, rhodium, or palladium) that oxidizes the excess hydrocarbons and CO to H_2O and CO_2, while reducing NO_x to N_2. NO_x reduction efficiencies are usually greater than 90 percent, while CO reduction efficiencies are approximately 90 percent.

The NSCR technique is effectively limited to engines with normal exhaust oxygen levels of4 percent or less. This includes 4-stroke rich-burn, naturally aspirated engines and some 4-stroke rich-burn, turbocharged engines. Engines operating with NSCR require tight air-to-fuel control to maintain high reduction effectiveness without high hydrocarbon emissions. To achieve effective NO_x reduction performance, the engine may need to be run with a richer fuel adjustment than normal. This exhaust excess oxygen level would probably be closer to 1 percent. Lean-burn engines could not be retrofitted with NSCR control because of the reduced exhaust temperatures.

Pre-Stratified Charge - Pre-stratified charge combustion is a retrofit system that is limited to 4-stroke carbureted natural gas engines. In this system, controlled amounts of air are introduced into the intake manifold in a specified sequence and quantity to create a fuel-rich and fuel-lean zone. This stratification provides both a fuel-rich ignition zone and rapid flame cooling in the fuel-lean zone, resulting in reduced formation of NO_x. A pre-stratified charge kit generally contains new intake manifolds, air hoses, filters, control valves, and a control system.

CONTROL TECHNIQUES FOR LEAN-BURN RECIPROCATING ENGINES

Selective Catalytic Reduction - Selective catalytic reduction is a post-combustion technology that has been shown to be effective in reducing NO_x in exhaust from lean-burn engines. An SCR system consists of an ammonia storage, feed, and injection system, and a catalyst and catalyst housing. Selective catalytic reduction systems selectively reduce NO_x emissions by injecting ammonia (either in the form of liquid anhydrous ammonia or aqueous ammonium hydroxide) into the exhaust gas stream upstream of the catalyst. Nitrogen oxides, NH_3, and O_2 react on the surface of the catalyst to form N_2 and H_2O. For the SCR system to operate properly, the exhaust gas must be within a particular temperature range (typically between 450 and 850F). The temperature range is dictated by the catalyst (typically made from noble metals, base metal oxides such as vanadium and titanium, and zeolite-based material). Exhaust gas temperatures greater than the upper limit (850F) will pass the NO_x and ammonia unreacted through the catalyst. Ammonia emissions, called NH_3 slip, are a key consideration when specifying a SCR system. SCR is most suitable for lean-burn engines operated at constant loads, and can achieve efficiencies as high as 90 percent. For engines which typically operate at variable loads, such as engines on gas transmission pipelines, an SCR system may not function effectively, causing either periods of ammonia slip or insufficient ammonia to gain the reductions needed.

Catalytic Oxidation - Catalytic oxidation is a post-combustion technology that has been applied, in limited cases, to oxidize CO in engine exhaust, typically from lean-burn engines. As previously mentioned, lean-burn technologies may cause increased CO emissions. The application of catalytic oxidation has been shown to be effective in reducing CO emissions from lean-burn engines. In a catalytic oxidation system, CO passes over a catalyst, usually a noble metal, which oxidizes the CO to CO_2 at efficiencies of approximately 70 percent for two stroke lean burn engines and 90 percent for four stroke lean burn engines.

(ref-AP-42, Fifth Edition, Volume I Chapter 3: Stationary Internal Combustion Sources)

Control Technologies for Diesel and Dual-Fuel Engines

The most common NO_x control technique for diesel and dual-fuel engines focuses on modifying the combustion process. However, selective catalytic reduction (SCR) and nonselective catalytic reduction (NSCR), which are post-combustion techniques are becoming available. Controls for CO have been partly adapted from mobile sources.

Combustion modifications include injection timing retard (ITR), pre-ignition chamber combustion (PCC), air-to-fuel ratio adjustments, and de-rating. Injection of fuel into the cylinder of a CI engine initiates the combustion process. Retarding the timing of the diesel fuel injection causes the combustion process to occur later in the power stroke when the piston is in the downward motion and combustion chamber volume is increasing. By increasing the volume, the combustion temperature and pressure are lowered, thereby lowering NO_x formation. ITR reduces NO_x from all diesel engines; however, the effectiveness is specific to each engine model. The amount of NO_x reduction with ITR diminishes with increasing levels of retard.

Improved swirl patterns promote thorough air and fuel mixing and may include a precombustion chamber (PCC). A PCC is an antechamber that ignites a fuel-rich mixture that propagates to the main combustion chamber. The high exit velocity from the PCC results in improved mixing and complete combustion of the lean air/fuel mixture, which lowers combustion temperature, thereby reducing NO_x emissions. The air-to-fuel ratio for each cylinder can be adjusted by controlling the amount of fuel that enters each cylinder. At air-to-fuel ratios less than stoichiometric (fuel-rich), combustion occurs under conditions of insufficient oxygen which causes NO_x to decrease because of lower oxygen and lower temperatures. Derating involves restricting the engine operation to lower than normal levels of power production for the given application. Derating reduces cylinder pressures and temperatures, thereby lowering NO_x formation rates.

SCR is an add-on NO_x control placed in the exhaust stream following the engine and involves injecting ammonia (NH_3) into the flue gas. The NH_3 reacts with NO_x in the presence of a catalyst to form water and nitrogen. The effectiveness of SCR depends on fuel quality and engine duty cycle (load fluctuations). Contaminants in the fuel may poison or mask the catalyst surface causing a reduction or termination in catalyst activity. Load fluctuations can cause variations in

exhaust temperature and NO_x concentration which can create problems with the effectiveness of the SCR system.

NSCR is often referred to as a three-way conversion catalyst system because the catalyst reactor simultaneously reduces NO_x, CO, and HC and involves placing a catalyst in the exhaust stream of the engine. The reaction requires that the O_2 levels be kept low and that the engine be operated at fuel-rich air-to-fuel ratios.

SULFUR OXIDES

Sulfur oxide emissions are a function of only the sulfur content in the fuel rather than any combustion variables. In fact, during the combustion process, essentially all the sulfur in the fuel is oxidized to SO_2. The oxidation of SO_2 gives sulfur trioxide (SO_3), which reacts with water to give sulfuric acid (H_2SO_4), a contributor to acid precipitation. Sulfuric acid reacts with basic substances to give sulfates, which are fine particulates that contribute to PM-10 and visibility reduction. Sulfur oxide emissions also contribute to corrosion of the engine parts.

Recent communications with representatives of natural gas producer Chesapeake Energy indicated that contractors that are providing some 80% of the diesel rigs to the industry are using ultra low sulfur fuel (15ppm) because of the reduced availability of the alternative low sulfur fuel.

The proposed revision of 40 CFR Part 63 Subpart ZZZZ “Engine MACT” described in Appendix 17 will mandate the use of ultra low sulfur fuel.

(ref-AP-42, Fifth Edition, Volume I Chapter 3: Stationary Internal Combustion Sources)

7.5.1.2 Natural Gas Production Facilities NESHAP 40 CFR Part 63, Subpart HH (Glycol Dehydrators)

For those area source TEG dehydration units with natural gas throughput and benzene emission rates above the cutoff levels described above that are located within the UA plus offset and UC boundary, each such unit must be connected, through a closed vent system, to one or more emission control devices. The control devices must: (1) reduce HAP emissions by 95 percent or more (generally by a condenser with a flash tank); or (2) reduce HAP emissions to an outlet

concentration of 20 parts per million by volume (ppmv) or less (for combustion devices); or (3) reduce benzene emissions to a level less than 1.0 ton/year). As an alternative to complying with these control requirements, pollution prevention measures, such as process modifications or combinations of process modifications and one or more control devices that reduce the amount of HAP generated, are allowed provided that they achieve the same required emission reductions.

For those area source TEG dehydration units with natural gas throughput and benzene emission rates above the cutoff levels described above that are located outside of UA plus offset and UC boundaries, each unit must reduce emissions by lowering the glycol circulation rate to be less than or equal to an optimum rate. The optimum rate is determined by the following equation:

$$LOPT = 1.15*3.0 \frac{galTEG}{lb\ H2O} * \frac{\{ F*(I - O)\}}{\{ 24hr/day \}}$$

Where:
LOPT = Optimal circulation rate, gal/hr.
F = Gas flowrate (MMSCF/D).
I = Inlet water content (lb/MMSCF), and
O = Outlet water content (lb/MMSCF).

The constant 3.0 gal TEG/lb H2O is the industry accepted rule of thumb for a TEG-to-water ratio. The constant 1.15 is an adjustment factor included for a margin of safety.

7.5.2 Mitigation Measures Resulting from Air Quality Impact Assessment

The modeling analysis conducted to date and described in Section 6.5.2 supports the following conclusions and possible mitigation measures to assure compliance with ambient air quality standards and other thresholds. Any deviations from the noted measures will require either equivalent mitigation for the particular exceedance or a site specific assessment:

1) Essentially all criteria pollutant impacts are found to meet the applicable PSD increments and ambient standards using the industry supplied emissions data and stack parameters. The annual NO2 impact calculations have incorporated an extension of the off-site compressor stack to a minimum of 7.6m (25ft), as also required by conclusions on non-criteria pollutant impacts. The 24 hour PM 10 and PM2.5 impacts are predicted to be above the corresponding standards, but no simple mitigation measures were indicated. However, a combination of a minimum stack height extension of 3.1m (10ft) for the sources controlling these impacts (the drilling rig engines and the hydraulic fracturing

engines) and the preclusion of public access in close proximity of the well pad area is determined to be one means to alleviate the exceedences. Alternative mitigation measures could be defined by industry to achieve compliance. Thus, the modeling analysis performed to date support the following mitigation measures for the criteria pollutants in order to meet all of the ambient thresholds:

a) the fuel oil to be used in the various operation engines must be limited to the ultra low sulfur content of 15ppm.

b) the compressor stack height must be a minimum of 7.6m (25ft).

c) To eliminate particulate standards exceedences, public access must be precluded from the pad area out to a minimum distance of 500m in all directions by erecting a fence or a comparable measure (e.g. posting of signs is not an acceptable measure). A smaller distance can be defined by refining the background levels or industry can propose alternate measures or controls.

2) The impacts of the non-criteria pollutants associated with the short term venting of "wet" gas, which contains certain VOC species, are well below the corresponding 1 hour guideline concentrations, with the exception of H2S. For the latter, a simple stack height increase to a minimum of 9.1m (or 30feet) for the flowback vent stack will resolve the exceedance.

3) All of non-criteria pollutant impacts from the combustion sources and the glycol dehydrator are well below the corresponding short term guideline levels. On the other hand, in order for the annual impacts to be below the corresponding annual guideline concentrations, the glycol dehydrator emissions of benzene must be limited to meet NESHAP requirements (i.e. use of condenser) and its stack height must be a minimum of 9.1m (30ft), while the off-site compressor must be equipped with an oxidation catalyst and its stack height must be a minimum of 7.6m (25ft).

4) If flowback impoundments are to be used, it will be necessary to exclude "solvent" and certain surfactants (containing benzene and xylene) from the current list of additives proposed by industry for use in fracturing operations. Furthermore, for the remaining chemicals, it is necessary to take steps to preclude public exposure to certain pollutant impacts by either eliminating their use or fencing in the impoundments. Specifically, for the smaller on-site impoundments, limiting public access to beyond approximately 150m from the impoundment would be one means of eliminating potential adverse impacts. On the other hand, for the larger centralized impoundment, public exposure to potential adverse impacts can be eliminated by erecting a fence at a rather large distance of approximately 1000m, or at a smaller distance if certain chemicals listed in Table 6.21 are eliminated. It is also determined that these larger off-site impoundments have the potential to qualify as a major source of Hazardous Air Pollutants (HAPs) due to certain chemicals. Thus, a case specific review might be required for these larger impoundments.

Finally, these conclusions are contingent on assuring that certain assumptions used in the modeling are verified. For example, there is a need to keep records of glycol use in the dehydrator for benzene emission calculations and operational logs of the various engine usage over a year's period as means to verify the modeling assumptions.

7.5.3 Summary of Air Quality Impacts Mitigation

7.5.3.1 Well Pad

The EAF Addendum will require information regarding stack heights and public access restrictions relative to the well pad. If stack heights shorter than those specified in Table 7.5 are proposed, then information must be attached to the EAF Addendum which demonstrates that other control measures will effectively prevent exceedances for the listed pollutants. Even with the 10-foot stack height for the drilling rig and truck-mounted hydraulic fracturing engines, a physical barrier to public access at least 500 feet from the well pad could be required unless the applicant demonstrates that specific control equipment will be used to further reduce particulate matter emissions during hydraulic fracturing operations.

Table 7.5 – Required Well Pad Stack Heights to Prevent Exceedences

Equipment	Pollutant	Stack Height
Drilling rig and truck-mounted hydraulic fracturing engines	Particulate matter	10 feet NOTE: physical barriers to public access may also required
Flowback vent/flare	H_2S	30 feet NOTE: not required if previous drilling at the same pad has demonstrated that H_2S is not present
Glycol dehydrator	Benzene	30 feet NOTE: Subpart HH compliance as described in Section 7.5.2.2 is also required.

The air dispersion modeling exercise described in Section 6.5.2 also determined that physical barriers to public access 500 feet from the wellsite would prevent exposure to HAPs from flowback water in an on-site reserve pit. However, as discussed elsewhere in this Supplement, uncertainties relative to potential flowback water volume and composition have led the Department to propose that flowback water not be directed to an on-site reserve pit but instead be held on the well pad in tanks prior to shipment to a disposal, treatment or re-use location.

The EAF Addendum will also require the operator to confirm use of ultra-low sulfur fuel (< 15 ppm).

7.5.3.2 Centralized Flowback Water Surface Impoundments

The EAF Addendum will require the operator to identify all proposed fracturing additives. Site-specific review of potential HAP emissions will be based on these proposed additives (i.e., components and concentrations) and assessing air quality impacts of these compounds might be necessary, unless the same additive mix has been previously analyzed for a similar centralized impoundment. The EAF Addendum will also require the operator to identify proposed control measures for preventing public exposure to HAPs in excess of guidance thresholds. These could consist of eliminating specific compounds such as methanol, heavy naptha and benzene; limiting the duration and use of the impoundment; covering the impoundment or placing physical barriers to public access. Information provided on the EAF Addendum will determine the required levels of SEQRA review and air permitting.

7.5.3.3 Off-Site Gas Compressors

The air modeling exercise also determined stack heights for equipment at centralized compressor stations; see Table 7.6. While these are governed by the separate PSC process described in Section 5.16.8, the Department will reference these findings as it participates in that process.

Table 7.6 – Stack Heights for Equipment at Centralized Compressor Stations

Equipment	Pollutant	Stack Height
Glycol dehydrator	Benzene	30 feet NOTE: Subpart HH compliance as described in Section 7.5.2.2 is also required.
Compressor	NO_2 Formaldehyde	25 feet NOTE: must also be equipped with an oxidation catalyst

7.6 Mitigating Greenhouse Gas Emissions

Potential greenhouse gas (GHG) emissions are discussed in Section 6.6, including estimates of total annual emissions of carbon dioxide (CO_2) and methane (CH_4) as both short tons and as carbon dioxide equivalents (CO_2e) expressed in short tons for expected exploration and

development of the Marcellus Shale and other low-permeability gas reservoirs using high volume hydraulic fracturing. The real benefit of the emission estimates comes not with quantifying possible emissions but from the identification and characterization of likely major sources of CO_2 and CH_4 during the anticipated operations. Identification and understanding of the key contributors of GHGs allows mitigation measures and future efforts to be efficiently focused. It was determined from the analysis included in Section 6.6 that ongoing yearly production activities from either a single well project or multi-well pad contribute significantly greater GHGs on a CO_2e basis than do the one-time operations necessary to mobilize, drill and complete wells. The following sections discuss possible mitigation measures for limiting GHGs, with particular emphasis on CH_4 because of its Global Warming Potential (GWP).

7.6.1 General

The United States Environmental Protection Agency's (USEPA) Natural Gas STAR Program is a flexible, voluntary partnership that encourages oil and natural gas companies – both domestically and abroad – to adopt cost-effective technologies and practices that improve operational efficiency and reduce emissions of CH_4, a potent greenhouse gas and clean energy source.[80] Natural Gas STAR partners can implement a number of voluntary activities to reduce GHG emissions from both exploration and production activities. The Department encourages active participation in the program. An example of a measure that could be included in a greenhouse gas emissions impacts mitigation plan includes:

- Proof of participation in the USEPA's Natural Gas STAR Program to reduce methane emissions (see Appendices 24 and 25)[81]

7.6.2 Site Selection

Site selection directly impacts the number of rig and equipment mobilizations needed to develop a well pad or area. Well operators can limit the generation of CO_2 by limiting vehicle miles traveled (VMT) and fuel consumption. Examples of measures that could be included in a greenhouse gas emissions impacts mitigation plan include:

[80] http://www.epa.gov/gasstar/

[81] http://www.epa.gov/gasstar/join/index.html

- Drilling as many wells as possible on a pad with one rig move,
- Spacing wells for efficient recovery of natural gas,
- Hydraulic fracturing as many wells as possible on a pad with one equipment move, and
- Planning for efficient rig and fracturing equipment moves from one pad to another.

7.6.3 Transportation

Transportation related to sourcing of equipment and materials, including disposal, was identified as a potential contributor of CO_2 emissions. Well operators can limit the generation of CO_2 by limiting VMT and fuel consumption. Examples of measures that could be included in a greenhouse gas emissions impacts mitigation plan include:

- Sourcing personnel and equipment from locations within the State or region,
- Using materials that are extracted and/or manufactured within the State or region,
- Recycling fluids at in-state facilities,
- Disposal or processing wastes at in-state facilities including disposal wells, and
- Using efficient transportation engines.

7.6.4 Well Design and Drilling

Well operators can limit GHG emissions during well drilling operations by effectively designing drilling programs. Examples of measures that could be included in a greenhouse gas emissions impacts mitigation plan include:

- Extending each lateral wellbore as far as technically and legally possible to reduce the total number of wells required within a spacing unit,
- Spacing the lateral wellbores for efficient recovery of natural gas,
- Re-using drilling fluids,
- Drilling overbalanced to limit/prevent venting and/or flaring of CH4,
- Using materials with recycled content (e.g., well casing, drilling fluids),

- Using efficient rig engines,
- Using efficient air compressor engines for drilling,
- Using efficient exterior lighting,
- Ensuring all flow connections are tight and sealed,
- Whenever possible, flaring methane instead of venting, and
- Performing leak detection surveys and taking corrective actions.

7.6.5 Well Completion

Well completion activities primarily contribute to GHG emissions from the internal combustion engines required for hydraulic fracturing and flaring operations during the flowback period. Examples of measures that could be included in a greenhouse gas emissions impacts mitigation plan include:

- Re-using flowback water,
- Using materials with recycled content (e.g., frac fluids),
- Using efficient hydraulic fracturing pump engines,
- Using efficient exterior lighting,
- Limiting flaring during the flowback phase by using reduced emissions completions (REC) equipment (see Appendix 25),
- If allowed by the Public Service Commission (PSC), constructing gathering lines so that the first well on a pad can initially be flowed into a sales line,
- Ensuring all flow connections are tight and sealed,
- Whenever possible, flaring methane instead of venting, and
- Performing leak detection surveys and taking corrective actions.

7.6.6 Well Production

As mentioned above, compared to any of the aforementioned operational phases, the ongoing production phase of any given well is the most significant period and contributor of GHGs, especially CH4. Natural gas compressors which run virtually around-the-clock, produce both

CO2 and CH4 emissions. Equipment required to process produced natural gas, specifically the glycol dehydrators (i.e., vents & pumps) and pneumatic devices, generate CH4 emissions during normal production operations. Examples of measures that could be included in a greenhouse gas emissions impacts mitigation plan include:

- Implementing USEPA's Natural Gas STAR Best Management Practices (BMP) including below:[82]
- Reducing Methane Emissions From Pneumatic Devices in the Natural Gas Industry[83]
- Reducing Methane Emissions from compressor rod packing systems[84]
- Reducing emissions when taking compressors off-line[85]
- Replacing Glycol Dehydrators with Desiccant Dehydrators[86]
- Replacing gas-assisted glycol pumps with electric pumps[87]
- Optimizing glycol circulation and installing flash tank separators in glycol dehydrators,[88]
- Using efficient compressor engines,
- Using efficient line heaters,
- Using efficient glycol dehydrators,
- Re-using produced waters,
- Ensuring all flow connections are tight and sealed,
- Performing leak detection surveys and taking corrective actions,
- Using efficient exterior lighting, and

[82] http://www.epa.gov/gasstar/tools/recommended.html

[83] http://www.epa.gov/gasstar/documents/ll_pneumatics.pdf

[84] http://www.epa.gov/gasstar/documents/ll_rodpack.pdf

[85] http://www.epa.gov/gasstar/documents/ll_compressorsoffline.pdf

[86] http://www.epa.gov/gasstar/documents/ll_desde.pdf

[87] http://www.epa.gov/gasstar/documents/ll_glycol_pumps3.pdf

[88] http://www.epa.gov/gasstar/documents/ll_flashtanks3.pdf

- Using solar-powered telemetry devices.

7.6.7 Mitigating Greenhouse Gas Emissions Impacts - Conclusion

Well operators can reduce their GHG emissions through active participation in the USEPA's Naural Gas STAR Program, and through effective planning and implementation of necessary activities. Supplementary permit conditions for high-volume hydraulic fracturing will include a requirement that the operator construct and operate the site in accordance with a greenhouse gas emissions impacts mitigation plan that may incorporate the above practices and considers, to the extent practicable, any relative Department policy documents. However, at a minimum, the plan must include the list of BMPs planned for implementation at the permitted well site and the first compressor facility receiving the well's production. Partners in USEPA's Natural Gas STAR Program should include proof of their participation and starting date. The operator's greenhouse gas emissions impacts mitigation plan shall be available to the Department upon request.

7.7 Mitigating Impacts from Centralized Flowback Water Impoundments

The potential use of large centralized surface impoundments to hold flowback water as part of a dilution and reuse system is described in Section 5.12.2.1. Potential impacts are discussed throughout Chapter 6 and summarized in Section 6.7. The mitigation measures that are identified in several sections above are summarized here. Conservative mitigation measures are proposed for centralized flowback water surface impoundments because of the following factors:

- The centralized surface impoundments are likely to be significantly larger than the well pad reserve pits,
- The centralized surface impoundments are likely to contain a greater volume of flowback water than is ever present on a well pad at one time,
- The centralized surface impoundments will be in use for longer periods of time than any well pad reserve pit, and
- As explained in Section 5.11.3, conservative measures are warranted because of the limited availability of information regarding flowback water characteristics.

The Department anticipates that, by the time the final SGEIS is published, additional data and analyses will be made public by the Marcellus Shale Committee and the Appalachian Shale Water Conservation and Management Committee. If so, this information and any further

information provided to the Department regarding flowback characteristics associated with Marcellus operations in the northern tier of Pennsylvania will be considered during the comment period before the SGEIS is finalized. If sufficient information is not provided before the SGEIS is finalized to support different protocols than are described herein, then any required site-specific environmental reviews in New York must be based on the operator's analysis, reviewed by the Department, of actual flowback data collected within reasonable proximity to the well pads that will be serviced by the proposed surface impoundment.

For SEQRA purposes, a centralized flowback water surface impoundment will be considered part of the project with the first well permit application that proposes its use. All well permit applications proposing use of a centralized flowback water surface impoundment will be considered incomplete until the Department has approved the impoundment. Location and construction of centralized flowback water surface impoundments and associated piping and conveyances will be reviewed pursuant to 6 NYCRR 554.1(c)(1), which requires approval, prior to well permit issuance, of a fluid disposal plan. As part of the application for a well permit, proposals will be reviewed individually to determine the level of SEQRA review, if any, that is required in addition to this Supplement.

The Department will not approve fluid disposal plans that propose centralized flowback water surface impoundments within the boundaries of primary and principal aquifers, unfiltered water supplies, or mapped 100-year floodplains. A site-specific SEQRA determination of significance will be required for any fluid disposal plan that proposes a centralized flowback water surface impoundment in any of the following locations:

- within 1,000 feet of a reservoir;
- within 500 feet of a perennial or intermittent stream, wetland, storm drain, lake or pond; and
- within 300 feet of a private or public water supply well.

To prevent potential impacts summarized in Section 6.7, the Department will apply the following review standards and requirements to proposed centralized flowback water surface impoundments:

1) If dam safety permitting criteria (Figure 5.5) are met, then construction must be in accordance with the Department's technical guidance document, *Guidelines for Design of Dams,* and operation must be in accordance with the Department's document, *An Owner's Guidance Manual for the Inspection and Maintenance of Dams in New York State.*

2) The specific provisions of 6 NYCRR Subpart 360-6 Liquid Storage will provide the overall requirements for flowback impoundments, describing the minimum liner, operational, monitoring and closure requirements.

    a. As provided by subdivision 360-2.14(a), the Department will consider proposals to use alternate liner materials provided the following requirements are met:

        i. High Density Polyethylene geomembranes must have a minimum thickness of 60 mils.

        ii. Linear Low Density Polyethylene geomembranes must have a minimum thickness of 40 mils.

        iii. Polyvinyl Chloride must have a minimum thickness of 30 mils and must be double hot wedge seamed with all field seams tested using the air channel test.

        iv. Certain reinforced geomembrane polymers also may be considered, in light of the durable nature of scrim-reinforced geomembranes which makes them more ideal for exposed applications.

    b. The lowermost composite liner may be designed with a geosynthetic clay liner in lieu of the two-foot thick clay barrier that is specified by Section 360-6.5.

3) The required fluid disposal plan must demonstrate that piping and conveyances used to convey flowback water to or from the centralized surface impoundment will be constructed of suitable materials, maintained in a leak-free condition, regularly inspected and operated using all appropriate spill control and stormwater pollution prevention practices.

4) The practices described in Section 7.4.1 of this Supplement must be employed to mitigate impacts related to invasive species.

5) The inner slopes of the impoundment that may come in contact with fluctuating levels of flowback water must be kept clear of vegetation.

6) The impoundment must be fenced and netting should be considered to prevent access by waterfowl or other wildlife.

7) Mitigation of potential air impacts will be determined by site-specific consideration of proposed additives, flowback analyses submitted by the operator from wells using the same additive mix, the duration and use of the impoundment, whether it will be covered and the distance surrounding the impoundment within which public access is restricted by a physical barrier such as a fence.

Many of the above practices address impacts that would be most effectively mitigated by use of covered tanks instead of open surface impoundments for centralized flowback water facilities. The provisions of 6 NYCRR Section 360-6.3 provide the regulatory standards that would apply to review of a fluid disposal plan submitted pursuant to 6 NYCRR 554.1(c)(1) that proposes the use of a centralized tank facility to manage flowback water.

7.8 Mitigating Naturally Occurring Radioactive Material (NORM) Impacts

7.8.1 State and Federal Responses to Oil and Gas Norm[89]

Discovery of elevated concentrations of NORM levels in other areas outside of New York in the 1980s led to a series of state and private investigations of the issue. State responses to the potential of elevated oil and gas NORM range from no action (barring self-reported problems) to decisions for further study, to implementation of new formal regulations and guidance documents. To date, no state has assessed the occurrence of NORM from longer duration drilling operations at multi-well sites and larger accumulations of shale cuttings from horizontal drilling. NORM is not subject to direct federal regulation (except its transport) under either the AEA or LLRWPA, and exploration and production (E&P) wastes are specifically exempt from regulation under Subtitles D and C of RCRA (LA Office of Conservation, 2009); however, NORM is regulated indirectly at the federal level through potential environmental impacts to drinking water (SDWA) and cleanup of abandoned hazardous waste sites (CERCLA and NCP).

The State of Louisiana was the first state to implement an oil and gas NORM regulatory program, and its program remains one of the most comprehensive to date. The Louisiana Department of Environmental Quality (LADEQ) has implemented a program that includes the identification, use, possession, transport, storage, transfer, decontamination, and disposal of oil and gas NORM to address the protection of human health and the environment. The primary NORM regulations are found in LAC 33:XV, Chapter 14: "Regulation and Licensing of

[89] Alpha, p. 2-44 et seq.

Naturally Occurring Radioactive Material (NORM)." A Memorandum of Understanding (MOU) between the LADEQ and the Louisiana Department of Natural Resources (LDNR) addresses the responsibilities of the two agencies with respect to E&P wastes contaminated with NORM.

Section 1403 of the Louisiana Administrative Code defines NORM as "any nuclide that is radioactive in its natural physical state (i.e. not man-made), but not including source, by-product, or special nuclear material." This broad definition includes much more than just E&P NORM. The action levels provided in Section 1404 for E&P equipment and land contaminated by NORM are provided in the following list. The statute does not apply to levels below those listed.

- NORM, NORM Waste, and NORM contaminated material > 5pCi/g above background of Ra-226 or Ra-228, or > 150 pCi/g of any other NORM nuclide.
- Equipment > 50 microroentgens per hour (µR/hr) at any accessible point
- Land averaged over any 100 square meters with no single noncomposited sample to exceed 60 pCi/g of soil
    - > 5 pCi/g above background of Ra-226 or Ra-228, averaged over the first 15 cm, and 15 pCi/g above background over each subsequent 15 cm; or
    - > 30 pCi/g of Ra-226 or Ra-228, averaged over 15 cm depth increments, provided the total effective dose equivalent from the contaminated land does not exceed 0.1 rem/year.

Louisiana follows the USEPA exemption of oil and gas produced waters as hazardous waste under RCRA, but understands that these fluids may contain substances harmful to human health and the environment (e.g. NORM). The Injection and Mining Division of the Louisiana Office of Conservation (LOC) regulates the subsurface injection of produced waters in compliance with the federal Underground Injection and Control (UIC) program established under the SDWA. The E&P Waste Management Section of the Environmental Division of the LOC regulates commercial E&P waste storage, treatment and disposal facilities and coordinates all UIC enforcement actions brought against Class II injection wells.

Section 1412 allows the treatment, transfer, and disposal of NORM wastes in accordance with the following:

- by transfer to a land disposal facility licensed by Louisiana Department of Environmental Quality (LADEQ), NRC, and an agreement state, or a licensing state;

- by alternate methods authorized by the LADEQ in writing upon application or upon LADEQ's initiative;

- For E&P waste containing NORM at concentrations not exceeding 30pCi/g of Ra-226 or Ra-228, by transfer to an E&P waste commercial facility regulated by the DNR for treatment, if certain conditions are met by the facility; and

- For E&P waste containing concentrations of NORM in excess of the limits in Subsection 1404-a.1, but not exceeding 200 pCi/g Ra-226 or Ra-228 and daughter products, by treatment at E&P waste commercial facilities specifically licensed by LADEQ for such purposes.

Chapter 14 of LAC 33:XV also presents specifics of NORM surveys (Section 1407); worker protection (Section 1411); licensing/permitting (Section 1408); removal/remediation (see licensing and permitting); storage (Sections 1414 through 1416); transfer for continued use; and release of sites, materials and equipment for unrestricted use (Section 1417).

The State of Texas has also developed comprehensive NORM regulatory programs. NORM is regulated in Texas under the Texas Radiation Control Act by three separate agencies: The Texas Department of State Health Services (TDSHS); The Railroad Commission of Texas (TXRRC); and the Texas Commission on Environmental Quality (TCEQ). The Radiation Control Program within the Radiation Safety Licensing Branch of TDSHS regulates the use, treatment, and storage of NORM under 25 Texas Administrative Code §289.259 "Licensing of Naturally Occurring Radioactive Material." The TXRRC regulates the disposal of oil and gas NORM under 16 Texas Administrative Code, Title 16, Part 1, Chapter 4, Subchapter F, §4.601 - 4.632; "Disposal of Oil and Gas NORM Waste". The TCEQ has jurisdiction over the disposal of other NORM wastes. Performance of NORM decontamination, and disposal by the owner through on-site land farming and/or injection well disposal is under the TXRRC's purview. Currently, TDSHS oil and gas NORM waste is defined as anything that constitutes, is contained in, or has contaminated oil and gas waste and exceeds the TDSHS exemption level of 50 µR/hr or has a concentration of 50 pCi/g. This includes E&P equipment, and scale deposits in equipment, but not natural gas or gas products or produced waters, which are exempt. NORM contaminated equipment must be identified using specified radiation survey equipment compliant with TDSHS

regulations. Persons who are involved with the disposal of oil and gas NORM must comply with provisions of the TDSHS regulation 25TAC §289.202 including:

- Radiation protection program;
- Occupations dose control;
- Surveys and monitoring;
- Signs and labels; and
- Record keeping.

O&G NORM disposal methods that are specifically prohibited by Chapter 4, Subtitle F, §4.611 include:

- Discharge to surface or groundwater;
- Spreading on public roads; and
- Burial or land farming except on lease where generated by rule.

All other disposal methods require permits. The Technical Permitting Section of the Oil and Gas Division of the TXRRC issues permits for injection well disposal of produced waters which contain dissolved NORM. The permits are in full compliance with the UIC Class II well regulations as defined under the SDWA.

7.8.2 Regulation of NORM in NYS

In New York State, the handling of radioactive material is regulated. Requirements for radioactive materials licensing, excluding medical and educational uses in New York City and entities under exclusive federal jurisdiction, are in the State Sanitary Code, Chapter 1, Part 16 (10 NYCRR 16) and Industrial Code Rule 38 (12 NYCRR 38). The New York State Department of Health is the licensing agency, and it enforces both Part 16 and Code Rule 38. Requirements for environmental discharges, waste shipment and disposal, or environmental cleanup are regulated by the NYS Department of Environmental Conservation (DEC) under its 6 NYCRR Part 380 series of regulations. There are also restrictions on disposal of radioactive materials in 6 NYCRR Part 360.

The overall licensing requirement for radioactive material, §16.100 of the State Sanitary code states, in part, that "no person shall transfer, receive, possess or use any radioactive material except pursuant to a specific or general license issued under this Part." Exemptions to the overall requirement are listed in Part 16, Appendix 16-A. In summary, any person is exempt from the requirements to the extent that such person transfers, receives, possesses or uses products or materials containing radioactive material in concentrations and quantities not in excess of those listed in the accompanying tables. Where multiple radionuclides are present, the sum of the ratios shall not exceed unity (one).

The discharge of radioactive material into the environment is regulated by DEC. NORM contained in the discharge of hydro-fracturing fluids or production brine may be subject to discharge limitations specified in Part 380. Effluent discharges cannot exceed the radionuclide-specific values established in Part 380-11.7. For Ra-226, this value is 6E-8 μCi/ml, or 60 pCi/l.

Analytical results from initial sampling of production brine from vertical gas production wells in the Marcellus formation have been reviewed and suggest that the potential for NORM scale buildup and other NORM waste may require licensing. The results also indicate that production water may be subject to discharge limitations established in Part 380.

Existing data from drilling in the Marcellus formation in other States, and from within NYS for wells that were not hydraulically fractured, shows significant variability in NORM content. This variability appears to occur both between wells in different portions of the formation and at a given well over time. This makes it important that samples from wells in different locations within NYS are used to assess the extent of this variability. During the initial Marcellus development efforts, sampling and analysis will be undertaken in order to assess this variability. These data will be used to determine whether additional mitigation is necessary to adequately protect the public health and environment of the State of New York.

In order to determine which gas production facilities may be subject to the licensing and environmental discharge requirements, radiological surveys and measurements are necessary including radiation exposure rate measurements of areas of potential NORM contamination, accessible piping, tanks or other equipment that could contain NORM scale buildup. Facilities

that possess NORM wastes or piping, tanks or other equipment with elevated radiation levels may need a radioactive materials license. Further, any discharge of effluents into the environment will need to be tested for NORM concentrations prior to discharge.

7.9 Protecting Visual Resources

7.9.1 Pad Siting[90]

As stated in 1992, many of the potential negative impacts of gas development hinge on the location chosen for the well and the techniques used in constructing the access road and well site. Before a drilling permit can be issued, DEC staff must ensure that the proposed location of the well and access road complies with the Department's spacing regulations and siting restrictions. To assist in this process, DEC staff now has access to Policy Guidance Document DEP-00-2, entitled: "Assessing and Mitigating Visual Impacts."

By applying the regulations and siting restrictions along with the guidance provided in DEP-00-2 as appropriate to well pad applications, it will be possible to avoid significant aesthetic impacts.

Specific visual impacts mitigation measures that should be considered include the following:

- Avoid locating rigs and structures so they will interrupt or obscure views of crestlines or ridgelines.
- In addition to siting the structures sensitively, consider how the building design (height, massing, etc.) will affect the visual impact of the site.
- Locate structures to have the least impact on views from surrounding properties.
- In grading and development, preserve salient natural features such as natural terrain, trees and groves, waterways and other similar resources; keep cut and fill operations to a minimum and ensure conformity to existing topography to the extent practical.

7.9.2 Lighting

Examples of other visual impacts mitigation techniques that should be considered involve lighting and could include:

- Directing site lighting downward and internally to the extent possible, and

[90] NTC, pp. 17-18

- Minimizing glare on public roads and adjacent buildings within a specified distance.
- Avoiding "uplights" and wall-washes, as well as lighting where the bulb is visible from the fixture.
- To the maximum practical extent, installing lighting fixtures so they do not cast light on the neighboring properties.

Safety of well site workers must be considered with respect to lighting techniques.

7.9.3 Reclamation

Well pads will be more substantially constructed than was addressed in 1992. A significant amount of crushed stone is brought in and compacted to stabilize the pad and access road to accommodate the equipment and truck traffic. As a result, it would be beneficial in reducing long term visual impacts if the 1992 GEIS topsoil conservation and redistribution practices required upon final plugging and abandonment in agricultural districts were required for all well pads.[91] The specific procedures are:

1) Strip-off and set aside topsoil during construction
2) Protect stockpiled topsoil from erosion and contamination
3) Cut well casing to a safe buffer depth of 4 feet below the surface
4) Paraplow the area before topsoil redistribution if compaction has occurred
5) Redistribute topsoil over disturbed area during site reclamation

The United States Bureau of Land Management's *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* has additional reclamation procedures that would be beneficial to mitigate visual impacts.[92] They include:

1) Re-Vegetation – Disturbed areas should be re-vegetated after the site has been satisfactorily prepared prepared with native perennial species or other plant materials specified by the surface management agency or private surface owner; site preparation should include re-spreading topsoil to an adequate depth for successful re-vegetation.

[91] NTC, p. 18

[92] NTC, p. 18

2) Pipeline Reclamation – Reclamation of pipelines includes re-contouring to the original contour, seeding, and controlling for noxious weeds.

3) Well Site Reclamation – to achieve final reclamation of an abandoned well site, the area should be re-contoured to blend into the contour of the surrounding landform, stockpiled topsoil evenly redistributed, and the site re-vegetated.

4) Road Reclamation – Reclamation of roads includes re-contouring the road to the original contour, seeding, and controlling for noxious weeds.

7.9.4 Protecting Visual Resources - Conclusion

The 1992 GEIS conclusion was that visual impacts from gas drilling and completion activities are primarily minor and short-term, and vary with topography, vegetation, and distance to viewer. It also found that both temporary disruptions of scenic vistas and long term changes in the landscape with the installation of production facilities will occur if the well is economically viable. Given that the visual issues are similar for horizontal drilling with high volume hydraulic fracturing these findings are still relevant. The most significant disruptions will be of a longer duration, particularly for multi-well pads, but they are still short term. The positive benefit of multi-well pads, as discussed previously, is that there will be fewer of them.[93]

Since visual impacts are most effectively addressed at the siting and design phase, it is important that the pad be properly located and planned. Horizontal drilling provides the flexibility to locate the pad in the best possible location and the utilization of multi-well pads will reduce the number of visual impacts in an area. New York State DEC guidance document "DEP-00-02 Assessing and Mitigating Visual Impacts" along with a site plan should be utilized for this purpose. Additionally, the applicant is encouraged to review any applicable local land use policy documents with the understanding that DEC retains authority to regulate gas development.[94]

Supplementary permit conditions for high-volume hydraulic fracturing will include a requirement that the operator construct and operate the site in accordance with a visual impacts mitigation plan that incorporates the above practices and considers, to the extent practicable, local land use policy documents. Municipalities are encouraged to identify and/or map other

[93] NTC, pp. 18-19

[94] NTC, p. 19

areas of high visual sensitivity and share this information with operators so they can potentially incorporate additional aesthetic mitigations into their visual impacts mitigation plans.

The operator's visual impacts mitigation plan shall be available to the Department upon request. The Department may require use of the Visual EAF Addendum and add further, site-specific visual mitigation requirements to individual permits if necessary to alleviate impacts to the visual resources listed in Section 2.4.11.

7.10 Mitigating Noise Impacts

7.10.1 Pad Siting[95]

Noise is best mitigated by distance. The further from receptors the lower the impact. The second level of noise mitigation is direction. Directing noise generating equipment away from receptors greatly reduces associated impacts. Timing also plays a key role in mitigating noise impacts. Scheduling the more significant noise generating operations during daylight hours provides for tolerance that may not be achievable during the evening hours.

As stated in 1992, many of the potential negative impacts of gas development hinge on the location chosen for the well and the techniques used in constructing the access road and well site. Before a drilling permit can be issued, DEC staff must ensure that the proposed location of the well and access road complies with the Department's spacing regulations and siting restrictions. To assist in this process DEC staff now has access to Policy Guidance Document DEP-00-1, entitled "Assessing and Mitigating Noise Impacts."

7.10.2 Access Road[96]

With the extensive trucking and associated noise that is involved with water transportation for high volume hydraulic fracturing, attention should be given to the location of the access road. When appropriate, it should be located as far as practical from occupied structures and places of assembly. The purpose is to protect non-lease holders from noise impacts associated with trucking that conflict with their property use.

[95] NTC, pp. 11-12

[96] NTC, p. 12

7.10.3 Multi-Well Pads

As discussed in the 1992 GEIS, moderate to significant noise impacts may be experienced within 1,000 feet of a well site during the drilling phase.[97] With the extended duration of drilling and other activities involved with multi-well pads, it is recommended that the pad not be located closer than 1,000 feet to occupied structures and places of assembly. When this threshold is infringed upon, DEC can add appropriate mitigating conditions to the permit if necessary. [98] Examples of noise mitigation techniques that can be implemented as site-specific permit conditions include the following:

- requirement for ambient noise level determination prior to operations;
- specified daytime and nighttime noise level limits and periodic monitoring thereof;
- placement of tanks, trailers, topsoil stockpiles or hay bales between the noise sources and receptors,
- use of noise reduction equipment such as hospital mufflers, exhaust manifolds or other high-grade baffling,
- limitation of drill pipe and workstring cleaning ("hammering") to certain hours,
- scheduling of bit trips and running of casing during certain hours to minimize noise from elevator operation,
- orientation of high-pressure discharge pipes away from noise receptors,
- placement of air relief lines and installation of baffles or mufflers on lines,
- limitation of cementing operations to certain hours,
- use of higher or larger diameter stacks for flare testing operations and
- placement of redundant permanent ignition devices at the terminus of the flow line to minimize noise events of flare re-ignition.

Many of these mitigation techniques have been successfully applied, when necessary, at wells drilled in New York. In addition, based upon the Department's recommendations, these

[97] GEIS, p. 8-11

[98] NTC, p. 12

mitigation measures have been incorporated into Environmental Assessments prepared by the Federal Energy Regulatory Commission for proposed natural gas storage projects in New York, contributing to that agency's findings the proposed projects would have no significant environmental impact.

7.10.4 Mitigating Noise Impacts - Conclusion

As discussed in the 1992 GEIS, temporary, short-term noise impacts will vary with the presence of topographic or vegetative barriers such as hills, trees and tall grass or shrubs. Drilling operations are the noisiest phase of development and usually continue 24 hours a day. Noise sources during the drilling phase include various drilling rig operations, pipe handling, compressors, and operations of trucks, backhoes, tractors and cement mixing. In most instances, the closest receptor is the residence of the property owner where the well is located and the owner has agreed to the disturbance by entering into a voluntary lease agreement with the well operator. Nevertheless, when necessary because of nearby receptors (regardless of lease status), noise impacts can be mitigated by a combination of site layout to take advantage of existing topography and special permit conditions.

The 1992 GEIS found that there were unavoidable negative noise impacts for those living in close proximity to a drill site. These were determined to be short term and could be mitigated with siting restrictions and setback requirements. Given that the noise issues have been found to be similar for horizontal drilling with high volume hydraulic fracturing these findings are still relevant. The extended time period does make control of the noise impacts, while still temporary, essential. Since noise control is most effectively addressed at the siting and design phase it is important that the pad be properly located and planned, and horizontal drilling provides the flexibility to accommodate this. New York State DEC guidance document "DEP-00-01 Assessing and Mitigating Noise Impacts" along with a site plan should be utilized for this purpose. Additionally, the applicant is encouraged to review any applicable local land use policy documents with the understanding that DEC retains authority to regulate gas development.[99]

Supplementary permit conditions for high-volume hydraulic fracturing will include the following requirements to mitigate potential noise impacts:

[99] NTC, p. 13

1) Unless otherwise required by private lease agreement, the access road must be located as far as practical from occupied structures, places of assembly and unleased property and

2) The well operator must operate the site in accordance with a noise impacts mitigation plan that incorporates specific practices and, to the extent practicable, local land use policy documents.

The operator's noise impacts mitigation plan shall be available to the Department upon request. Additional, site specific noise mitigation measures will be added to individual permits if a well pad is located within 1,000 feet of occupied structures and places of assembly.

7.11 Mitigating Road Use Impacts

Under New York State Highway Vehicle Traffic Laws, local municipalities retain control over their roads. This makes it important for municipalities to monitor the NYSDEC web site for information regarding gas development in their areas. Local governments (County, Town and Village) should be proactive in exercising their authority under New York State Highway Vehicle Traffic Laws. This would include the completion of a road system integrity study to potentially assess fees for maintenance and improvements.[100] The applicant should attempt to obtain a road use agreement with the municipality or document the reasons for not obtaining one. When there is no agreement, operators should develop a trucking plan that includes estimated amount of trucking, hours of operations, appropriate off road parking/staging areas, and routes for informational purposes.

Examples of measures that could be included in a road use agreement or trucking plan include:

- route selection to maximize efficient driving and public safety,
- avoidance of peak traffic hours, school bus hours, community events, and overnight quiet periods,
- coordination with local emergency management agencies and highway departments,
- upgrades and improvements to roads that will be traveled frequently for water transport to and from many different well sites,
- advance public notice of any necessary detours or road/lane closures,

[100] NTC, p. 22

- adequate off-road parking and delivery areas at the site to avoid lane/road blockage, and
- use of rail or temporary pipelines where feasible to move water to and from well sites.

Supplementary permit conditions for high-volume hydraulic fracturing will re-emphasize that issuance of a well permit does not provide relief from any local requirements authorized by or enacted pursuant to the NYS Vehicle and Traffic Law. The permit conditions will additionally require the following:

1) Prior to site disturbance, the operator shall submit to the Department, for informational purposes only, a copy of any road use agreement between the operator and municipality.

2) If no road use agreement has been reached, the operator shall file its trucking plan with the Department, for informational purposes only, along with documentation of its efforts to reach a road use agreement.

7.12 Mitigating Community Character Impacts

Based on NTC Consultants' evaluation for NYSERDA, Section 6.12 identified trucking (i.e., road use), land use changes and environmental justice as community character impacts requiring discussion in this Supplement.

7.12.1 Trucking

One of the largest and most obvious potential impacts of the proposed activity on community character is the issue of trucking to support high-volume hydraulic fracturing. [101] While local authorities retain control over local roads, the Department strongly encourages operators and municipalities to attain road use agreements. The road use agreement, or the operator's trucking plan if no agreement is reached, will be on file with the Department. The Department encourages the use of mitigation measures listed in Section 7.11, along with others deemed prudent by the local governing authority.

7.12.2 Land Use

As stated in Section 6.12.1, the multi-well pad development method "will reduce the cumulative changes to the host community, and should minimize loss or fragmentation of habitats,

[101] NTC, p. 23

agricultural areas, forested areas, disruptions to scenic view sheds, and the like."[102] Nevertheless, the Department recognizes the concern that local communities have regarding the scale and potential effects of the proposed activity; therefore, the EAF Addendum submitted with each well permit application will require the applicant to attest to having reviewed any existing comprehensive, open space and/or agricultural plan or similar policy document(s). Whenever possible, full consideration should be given to locating the well pad in an area that has been previously disturbed.

7.12.3 Environmental Justice

As stated in Section 6.12.2, the current "SGEIS/SEQRA process provides opportunity for public input and the resulting permitting procedures will apply statewide and provide equal protection to all communities and persons in New York."[103] Therefore, no additional procedures or mitigation measures are necessary to address environmental justice with respect to the proposed activity.

7.13 Mitigating Cumulative Impacts

Mitigation of cumulative impacts associated with water withdrawal for hydraulic fracturing is discussed in Section 7.1.1.8.

Regarding other types of cumulative impacts, as determined by NTC in its study for NYSERDA and paraphrased in Section 6.13.2.1, "The rate of development cannot be predicted with any certainty ... Nor is it possible to define the threshold at which development results in unacceptable adverse noise, visual and community character impacts… There is no way to objectify these inherently subjective perspectives [and] …there is no sound basis for an administrative determination limiting the shale development at this time.

The appropriate approach for minimizing cumulative impacts associated with noise, aesthetics, traffic and community character, therefore, is to encourage and adhere to the following practices:

- careful siting of well pads,

[102] NTC, p. 23

[103] NTC, p. 23

- use by the operators of site-specific visual and noise impact mitigation plans,
- negotiation of road use agreements with the appropriate local governing authorities, and
- recognition of and, to the extent practical, attention to local planning documents and policies.