

Policy Consideration:

Water Availability

Status:

**For Consideration by the Highlands Council at
the September 28, 2006 Work session**

Date:

September 26, 2006

EXECUTIVE SUMMARY

The Highlands Act recognizes the importance of the Highlands Region as the “essential source of drinking water, providing clean and plentiful drinking water for one-half of the State's population.” The need to ensure adequate water supplies is fundamental to ensuring that there are adequate water supplies to support human development and activities in the Highlands Region and in those areas of the State which rely on Highlands waters. In addition, water availability is fundamental to the protection of the important ecological values in the Highlands Region.

The following analysis recommends the use of low flow stream statistics to provide the best regionally available scientific method for estimating capacity of Highlands ground water supplies to maintain both ecological flow needs and sustainable human consumption. The low flow margin of safety methodology provides an estimate of ground water availability based on projected changes in a base flow of a stream. This methodology is an important tool to provide reliable estimates of water availability that can be used as sustainable land use capacity thresholds.

The purpose of this approach is to determine ground water availability thresholds by taking ground water capacity estimates for each subwatershed in the Highlands Region and multiplying those capacity estimates by selected percentages that are related to the nature of the environmental resources and conservation objectives of the Regional Master Plan for each regional zone in the Land Use Capability Map. In addition, the approach includes the need to identify source water protection areas as those subwatersheds that contribute to and include a surface water supply reservoir or potable on-stream water supply intakes in the Highlands Region.

Staff's specific recommendations are set forth in the following section and listed by number.

I. STAFF POLICY RECOMMENDATIONS

1. Estimate **Ground Water Capacity** for each subwatershed using the **Low Flow Margin of Safety Method**. Adjust the results to reflect consumptive uses in reference drainage basins.

Rationale: The RMP Standards support the necessity to determining the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values thereof, with special reference to surface and ground water quality and supply. Section 11.a.(1)(a). The Highlands Act does not specify a method to determine ground water capacity, and therefore this policy paper recommends a technically sound method, based on available information, that addresses the intent of the Act. The use of low flow stream statistics provides the best regionally available scientific method for estimating capacity of ground water supplies to maintain both ecological flow needs and sustainable human consumption. The Low Flow Margin of Safety Method is focused on September as the month that historically has the lowest median flows, and is based on statistical analyses using reference drainage basins with minimal consumptive uses. The initial estimates of groundwater capacity for each subwatershed are then adjusted by multiplying the Low Flow Margin by 1.02 to correct for consumptive uses within reference drainage basins (2 percent of the Low Flow Margin, on average, for basins with readily available data).

2. Establish **Ground Water Availability** thresholds by multiplying Ground Water Capacity by selected percentages that are related to the nature of the environmental resources and conservation objectives of the RMP for each regional zone in the Land Use Capability Map. Identify **Source Water Protection Areas** as those subwatersheds that contribute to and include a surface water supply reservoir or potable on-stream water supply intakes in the Highlands Region. Modify Net Water Availability to protect the safe yield of these surface water supplies.

Standards for Estimating Ground Water Availability		
Land Use Capability Map Area	Ground Water Availability Thresholds (as a Percent of Ground Water Capacity)	Ground Water Availability Thresholds for Subwatersheds Draining to Surface Water Intakes and Reservoirs (as a Percent of Ground Water Capacity)
Regional Protection Zone	5	5
Regional Conservation Zone	10	5
Regional Development Zone	20	10

Rationale: The Low Flow Margin of Safety Method was developed by the United States Geological Survey (USGS) based on nationally accepted statistical approaches. It is an important tool to provide reliable estimates of water availability that can be used as sustainable land use capacity thresholds. However, care needs to be taken to recognize the limitations in available data to address the inherent uncertainties regarding estimates of water availability (regardless of the method used) in order to avoid over allocation of water resources. This can be accomplished by using conservative thresholds (as a percent of the low flow margin) of estimating water availability.

The low flow margin methodology estimates ground water availability based on projected changes in a base flow of a stream. Ground water recharge is an important consideration in helping to maintain base flow. Increases in impervious cover from past development activities within a subwatershed can reduce the amount of groundwater that is available as base flow and, as such, limits the amount of groundwater that is available for consumptive human use. However, the relationship is complex and not necessarily a 1:1 ratio. These and other data uncertainties can be addressed through establishing thresholds of water availability that are deliberately conservative to stringently limit the risk that the Ground Water Availability estimates do not impair the ecological processes of a stream. The proposed thresholds of water availability are intended to address the following limitations, including but not limited to: climate change; watershed and land use changes; gauging stations limitations such as placement of stations and length of record; limitations in understanding of the relationship between stream flow and aquatic ecosystem integrity; variation of impacts within individual watersheds and sub-watersheds based on past water use and land use patterns including loss of recharge due to impervious cover.

The threshold of water availability for the Regional Protection Zone is highly protective of stream flows in order to maintain the integrity of aquatic ecosystems. Consumptive and depletive water uses (and the associated land uses) within this zone is stringently limited to ensure protection of the ecosystem. The Regional Conservation Zone recognizes that significant ecological resources also exist in these areas and the thresholds on availability limit consumptive and depletive water use to be very protective of these resources. However, it is recognized that agricultural water uses will occur in this zone as well as limited, low density development. The Regional Development Zone threshold is based on an empirical examination of known watershed issues regarding stream flows and aquifer capacity; the threshold is set

below the level at which reductions in stream flow have shown evidence of these impacts. In limited circumstances, there may be justification to allow a higher percentage of water availability where it can be demonstrated through subsequent detailed hydro-ecological studies that such an increase is sustainable. However, in the absence of those studies a lower percentage of water availability is recommended. Also a factor is the Preservation Area requirement in Section 34.d of the Highlands Act that NJDEP water allocations permits ensure maintenance of stream base flows, minimization of depletive use, maintenance of existing water quality, and protection of ecological uses.

Upstream consumptive and depletive uses can reduce safe yields for downstream surface water supplies. This policy reserves nearly all water capacity for maintaining base flow to protect against loss of system safe yields due to upstream consumptive and depletive uses. However, it also recognizes that a certain level of water use should be accommodated if that water is returned to the system essentially unchanged in quantity and quality, so that downstream water users are not harmed. The percentages recommended will allow a minimal amount of consumptive use within the Regional Protection and Conservation Zones (5 percent) and a slight higher level within the Regional Development Zone (10 percent).

Future research is needed to provide additional understanding of the ecological flow needs of streams and the implications of the change in land use condition, such as loss of recharge, on maintenance of base flow. Subsequent analysis may allow for adjustments of water availability thresholds where it can be demonstrated that there will be no impairment on the ecology of the stream, or may allow for development of new methods that provide for more detailed analysis of water availability estimates. (see Section III).

3. Estimate **Net Ground Water Availability** by subtracting from Ground Water Availability an estimate of maximum monthly consumptive ground water and surface water use (other than from reservoir storage) for that subwatershed.

Rationale: Most ecological impacts of ground water use relate to stream base flow reductions exhibited in the months of September and October; both NJGS and USGS models indicate that flows in those months are related to periods of maximum withdrawal (generally July or August), reflecting a lag effect. Although annual base flow reductions are roughly equal to the annual consumptive use, the available ground water models indicate that the impact of the maximum month use on September flows is not 1:1, but roughly 1:0.9. Therefore, the consumptive use estimates for each subwatershed is adjusted to account for this effect (multiplying the USGS maximum monthly consumptive use estimates by 0.9).

Surface water consumptive withdrawals (other than from reservoirs) have the same impact on aquatic ecosystems as the consumptive use of ground waters. Unlike ground water uses, the effects are direct and immediate and so no adjustment factor is needed. The effects of reservoir withdrawals are more complicated because they come from storage, rather than necessarily from stream flow, and therefore are addressed in Recommendation 5.

4. Based on available information, identify subwatersheds that may require adjustments to Net Water Availability to account for both the **exportation and importation** of ground water and surface water from and to that subwatershed.

Rationale: Ground and surface water exports (also known as depletive uses) reduce base flow beyond the effects of consumptive uses, while imports can add to base flow during critical periods. Therefore, all need to be accounted for to understand water availability. Developing an understanding of these impacts requires a detailed knowledge of how withdrawals are linked to water supply service areas, how water supply service areas are linked to wastewater service areas, and how the wastewater service areas are linked to effluent discharges. While each wastewater service area generally has a single discharge point, many water supply service areas have multiple water sources (e.g., well fields, purchases from

other water purveyors, combined reservoir/well field operations). Although both the withdrawal and discharge points are known, the linkages are not fully known at this time. Information has been collected on water withdrawals that may be depletive water uses (exports) and known effluent returns that may be imports, provided separately for each subwatershed. These can be used qualitatively identify areas in need of further analysis, but cannot be directly subtracted from or added to New Water Availability without further research.

5. Identify **Water Availability Deficit Areas** where the Net Water Availability is less than zero. Identify **Current Water Availability Constrained Areas** as subwatersheds that are upstream of and contributing flow to a HUC14 subwatershed with consumptive and depletive water uses that exceed 20% of Ground Water Capacity, regardless of LUCM zone.

Rationale: Where Net Water Availability is already negative, this is a clear indication that existing water uses are exceeding available water resources and pose a significant threat to the surface water supplies or the integrity of Highlands waters and the aquatic ecosystems on which they depend. Measures will be needed to the maximum extent practicable so that the Net Water Availability is no longer negative, and preferably is positive. Options include limiting future consumptive and depletive uses, reducing existing consumptive and depletive water uses or providing alternative water supplies from other resources (where water and infrastructure is available). This analysis must occur on a subwatershed or watershed basis, as appropriate.

6. Identify **Future Water Availability Constrained Areas** where consumptive water uses at full allocation exceed Net Water Availability.

Rationale: Projection of consumptive water uses at full allocation (maximum permitted withdrawals based on NJDEP water allocation permits) provides an indicator of the potential future stress on water resources based on existing NJDEP permits, assuming that no constraints exist on development to reduce those demands. In these areas, the RMP should reduce projected consumptive and depletive uses through land use controls and other measures to avoid exceeding water availability thresholds.

(*) ZONE AND SITE STANDARDS

[These standards are to be applied at the zone and site plan level. Following each bullet is language that is proposed for inclusion in the Policy Guidance Element of the Plan. Though Members will have the opportunity to review that language when you review the Policy Guidance Element, your input at this juncture would be very beneficial.]

7. The following standards shall be incorporated into the **Regional Protection Zone** of the Land Use Capability Map (LUCM), as follows:
 - Restrict consumptive and depletive uses of ground and surface waters by HUC14 subwatershed to no more than 5 percent of Ground Water Capacity based on the Low Flow Margin method.
 - Restrict consumptive and depletive uses of ground and surface waters within **Source Water Protection Areas** to no more than 5 percent of Ground Water Capacity based on the Low Flow Margin method.
 - Give highest priority for the use of Net Water Availability to Specially Planned Areas and TDR Receiving Areas as determined by the Highlands Council.

- Develop management plans to reduce consumptive and depletive uses of ground and surface waters in Water Availability Deficit Areas within this zone to restore the deficit, to the maximum extent practicable.

Rationale: The first goal of the Highlands Act for the RMP in both the Preservation Area and Planning Area is to protect, restore and enhance the quality and quantity of surface and ground waters. The Act requires the development of Land Use Capability Map and minimum standards based upon the Resource Assessment and Smart Growth Component. Section 11.a.(1) and (6), and Section 12. The Resource Assessment provisions emphasize the importance of determining the amount and type of human development and activity that the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values, with special reference to surface and ground water quality and supply. The Regional Protection Zone contains the most concentrated areas of contiguous, high quality environmental resources, and therefore consumptive and depletive uses of ground and surface waters should be very stringently limited within this zone. Also a factor is the Preservation Area requirement of Section 34 that NJDEP water allocations permits ensure maintenance of stream base flows, minimization of depletive use, maintenance of existing water quality, and protection of ecological uses.

8. The following standards shall be incorporated into the **Regional Conservation Zone** of the Land Use Capability Map, as follows:

- Restrict consumptive and depletive uses of ground and surface waters to no more than 10 percent of Ground Water Capacity based on the Low Flow Margin method.
- Restrict consumptive and depletive uses of ground and surface waters within **Source Water Protection Areas** to no more than 5 percent of Ground Water Capacity based on the Low Flow Margin method, unless detailed safe yield studies demonstrate that increased levels, not to exceed a 10 percent maximum, can be sustained without reducing existing safe yields.
- Give highest priority for the use of Net Water Availability to agricultural producers using best management practices for irrigation, and to Specially Planned Areas or TDR Receiving Areas as determined by the Highlands Council.
- Develop management plans to reduce consumptive and depletive uses of ground and surface waters in Water Availability Deficit Areas within this zone to restore the deficit, to the maximum extent practicable.

Rationale: The Highlands Act requires the development of Land Use Capability Map and minimum standards based upon the Resource Assessment and Smart Growth Component. Section 11.a.(1) and (6) and Section 12. The Resource Assessment provisions emphasize the importance of determining the amount and type of human development and activity that the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values, with special reference to surface and ground water quality and supply. The Rural Conservation Zone includes both significant agricultural areas and sensitive natural resources. Therefore consumptive and depletive uses of ground and surface waters should be limited within this zone. Priority for additional consumptive uses, where Net Water Availability is positive, should be to agricultural uses, in recognition of the Highlands Act provision for the promotion of compatible agricultural uses and opportunities. Similar provisions exist for brownfield restoration and redevelopment, which also would receive priority as Specially Planned Areas. Section 10.b.

9. The following standards shall be incorporated into the **Regional Development Zone** of the Land Use Capability Map, as follows:

- Restrict consumptive and depletive uses of ground and surface waters to no more than 20 percent of Ground Water Capacity based on the Low Flow Margin method, unless detailed, watershed-based

hydro-ecological studies demonstrate that a higher percentage, not to exceed 30 percent, can be sustained without harming the integrity of Highlands waters, aquatic ecosystems or other water uses.

- Restrict consumptive and depletive uses of ground and surface waters within **Source Water Protection Areas** to no more than 10 percent of Ground Water Capacity based on the Low Flow Margin method, unless detailed safe yield studies demonstrate that increased levels, not to exceed a 20 percent maximum, can be sustained without reducing existing safe yields.
- Develop management plans to reduce consumptive and depletive uses of ground and surface waters in **Water Availability Deficit Areas** within this zone to restore the deficit, to the maximum extent practicable.
- Give highest priority for allocation of net available water capacity to Specially Planned Areas or regional growth areas that can accommodate TDR Receiving Zones.

Rationale: The Highlands Act requires the development of Land Use Capability Map and minimum standards based upon the Resource Assessment and Smart Growth Component. Section 11.a.(1) and (6) and Section 12. These provisions emphasize protection of Highlands resources, but then encourage development that is consistent with smart growth and State Development and Redevelopment Plan provisions, is supported by infrastructure, and will result in appropriate development patterns.

10. The following **Resource Protection Standards** are recommended, including:

- Limit consumptive and depletive water uses in Current Water Availability Constrained Areas to 5% of the Ground Water Capacity to ensure continued stream flows to downstream Water Availability Deficit Areas.
- Ensure best management practices for agricultural irrigation practices through all available state and federal programs.
- Require that proposed consumptive or depletive water uses within Water Availability Deficit Areas or a Current Water Availability Constrained Areas be required to provide mitigation equal to 125% of the proposed new consumptive or depletive water uses through a permanent reduction of existing consumptive and depletive water uses.

Rationale: The RMP Standards support the necessity to determining the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values thereof, with special reference to surface and ground water quality and supply. Section 11.a.(1)(a). The Highlands Act requires the development of Land Use Capability Map and minimum standards based upon the Resource Assessment and Smart Growth Component. Section 11.a.(1) and (6) and Section 12.

11. The following **Smart Design Standards** are recommended, including:

- Establish mandatory water recycling/reuse measures within Specially Planned Areas, to minimize net water use.
- Establish mandatory stormwater reuse for irrigation purposes within Specially Planned Areas to minimize both the volume of stormwater discharges and water withdrawals for irrigation purposes.
- Require use of water conservation devices for any redevelopment or development activity including renovations to existing single family residences and commercial/industrial buildings.

Rationale: The RMP Standards support the necessity to determining the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values thereof, with special reference to surface and ground water quality and supply. The Highlands Act requires the development of Land Use Capability Map and

minimum standards based upon the Resource Assessment and Smart Growth Component. Section 11.a.(1) and (6) and Section 12. Water capacity should be used efficiently in all cases. Therefore, standards are needed to ensure water conservation, and also beneficial reuse of wastewater on-site to both reduce consumptive water uses and reduce effluent discharges.

12. The following **Regional Growth Standards** are recommended, including:

- Require that wastewater management plans or amendments demonstrate that the proposed service area will not directly or indirectly result in an exceedance of the Net Water Availability or an increase in the severity of a Water Availability Deficit Area.
- Give highest priority for allocation of remaining New Water Availability to TDR Receiving Zones adopted by a municipality and approved by the Highlands Council.

Rationale: The RMP Standards support the necessity to determining the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values thereof, with special reference to surface and ground water quality and supply. Section 11.a.(1)(a). The Highlands Act requires the development of Land Use Capability Map and minimum standards based upon the Resource Assessment and Smart Growth Component. Section 11.a.(1) and (6) and Section 12. The RMP establishes areas suitable for sewer service based on goals and provisions of the Highlands Act, and therefore wastewater management plans should likewise be in conformance with the RMP. Because expansion of sewer service areas can increase depletive water uses (transfers) it is important to ensure that the wastewater management plans are compatible with Highlands water availability. In addition, allocation of water availability to TDR Receiving Zones maximizes the benefit of the capacity to society, supporting both compact development forms and the preservation of critical natural resources (in the TDR Sending Zones).

(*) POST ADOPTION, COORDINATION AND PARTICIPATION STRATEGIES

[Following each bullet is language that is proposed for inclusion in the Policy Guidance Element of the Plan. Though Members will have the opportunity to review that language when you review the Policy Guidance Element, your input at this juncture would be very beneficial.]

13. The following **Pre-Conformance Strategies** are recommended to ensure successful implementation of the RMP prior to the conformance period, including:

- Establish growth thresholds by municipality based on limitations in Net Available Water.
- Develop technical guidelines and procedures for Low Impact Development (LID) best management practices (BMPs) to mitigate for losses to base flow as a result of consumptive or depletive water uses.
- Develop detailed management recommendations of subwatershed water withdrawal impacts and evaluate regulatory implications for **Water Availability Deficit Areas, Current Water Availability Constrained Areas or Future Water Availability Constrained Areas** (e.g., areas that exhibit a current or projected water availability deficit).

Rationale: RMP Implementation Strategies support the necessity to determine what activities, data and programs will be required of both the Highlands Council and municipal and county stakeholders during the Plan Conformance process as well as what initiatives will require longer term planning goals. Sections 11.a.(3),14 and 15. The RMP is a “living document” and will continue to be refined and developed in support of regional planning goals. In order to facilitate regional planning goals it is imperative that the RMP have State, County, and local support from all levels of government and the

support of the stakeholders of the Highlands Region. For water supply planning, municipalities will need guidance on how to use Net Water Availability results based on HUC14 subwatersheds within their local planning process and development review ordinances. For specific subwatersheds, further analysis of depletive water uses will be needed to provide this guidance.

14. The following **Conformance strategies** are recommended to ensure successful implementation of the RMP during the conformance period, including:

- Require amendments to wastewater management plans within **Water Availability Deficit Areas, Current Water Availability Constrained Areas or Future Water Availability Constrained Areas** to demonstrate that the proposed service area will not directly or indirectly contribute to an exceedance of the Net Water Availability or an increase in the severity of a water availability deficit.
- Require that thresholds and limitations of ground water availability be included in Municipal Master Plans and implementing land use ordinances.

Rationale: RMP Implementation Strategies support the necessity to determine what activities, data and programs will be required of both the Council and municipal and county stakeholders during the Plan Conformance process as well as what initiatives will require longer term planning goals. Sections 11.a.(3), 14 and 15. The RMP is a “living document” and will continue to be refined and developed in support of regional planning goals. In order to facilitate regional planning goals it is imperative that the RMP have State, County, and local support from all levels of government and the support of the stakeholders of the Highlands Region. Ensuring conformity of wastewater management plans to the water availability provisions of the RMP (and by extension, to the local plans based on their conformance with the RMP) will ensure that wastewater service areas are compatible with the quantity of available water and the priorities for its use.

15. The following **5-year Resource Protection and Planning Goals** are recommended to promote continued refinement and development of the RMP, including:

- Develop a program for improving estimates of Net Water Availability, including testing, development and adoption of ecologically based assessment techniques to evaluate the flow needs of streams necessary to maintain the health of aquatic ecosystems, and its relationship with consumptive water uses and estimates of water availability for both ground and surface water resources.
- Evaluate potable water supply reservoir Safe Yield and Passing Flow requirements and examine the effects of passing flows on Highlands open waters and the effects of upstream consumptive and depletive water uses on safe yields. Recommend regulatory changes to NJDEP as appropriate.
- Develop a more refined Hydrologic Unit Map using high resolution digital elevation modeling (LiDAR) to provide more detailed geographic estimates of water availability.
- Develop more refined estimates of the effects on Net Water Availability regarding the exportation and importation of water and wastewater.

Rationale: The Highlands Act requires the Highlands Council to periodically revise and update the RMP at least once every six years. Section 8.a. RMP Implementation Strategies support the necessity to determine what activities, data and programs will be required of both the Council and municipal and county stakeholders during the Plan Conformance process as well as what initiatives will require longer term planning goals. The RMP is a “living document” and will continue to be refined and developed in support of regional planning goals. In order to facilitate regional planning goals it is imperative that the RMP have State, County, and local support from all levels of government and the support of the stakeholders of the Highlands Region. Sections 11.a.(3), 14 and 15. Implementation of the science

agenda and the other recommendations will provide a continuing improvement to the scientific basis of water availability estimates.

16. The following **Coordination and Consistency Considerations** are recommended to promote active participation in the implementation of the RMP among state and federal agencies:

- Develop a coordinated monitoring program with the New Jersey Department of Environmental Protection to track ground water and surface water uses within the Highlands and improve consumptive and depletive use estimates.
- Develop a coordinated monitoring program with the New Jersey Department of Environmental Protection and the United States Geological Survey to track ground water levels and surface water flows to fill critical data gaps.
- Develop a coordinated regulatory review program with the New Jersey Department of Environmental Protection to ensure consistency of water allocations, safe yield, mandatory passing flows and inter-basin transfers with the resource protection goals of the RMP.
- Collaborate with the New Jersey Department of Environmental Protection to develop standardized methods for evaluating and updating safe yield of potable water supply reservoirs and surface water intakes.
- Coordinate with New Jersey Department of Environmental Protection to discourage the net increase in water resources transfers, from any HUC14 subwatershed that may cause or contribute to a deficit in available water resources.
- Collaborate with the New Jersey Geological Survey to further refine and develop an Ecological Flow Goals model for subsequent application in the Highlands that evaluates the affects of water and land use on the ecological flow regimes of Highlands waters.
- Develop technical guidance with the New Jersey Department of Agriculture to promote best management practices for water conservation, water reuse and irrigation efficiency in farm operations.
- Develop technical guidance and implementation approaches with the New Jersey Department of Environmental Protection to promote water conservation measures and mitigate for water distribution system losses in Highlands municipalities and in municipalities supplied with Highlands water.

Rationale: RMP Implementation Strategies support the necessity to determine what local, State, and federal programs and policies may best be coordinated to promote the goals, purposes, policies, and provisions of the RMP. Sections 11.a.(4). The RMP is a “living document” and will continue to be refined and developed in support of regional planning goals. In order to facilitate regional planning goals it is imperative that the RMP have State, County, and local support from all levels of government and the support of the stakeholders of the Highlands Region. Coordination on water use management issues will be a critical aspect of RMP implementation.

17. The following **Local Participation Considerations** are recommended to promote the understanding and support for the RMP resource protection goals at the local level:

- Develop educational program for municipal officials on water conservation measures and LID BMPs to reduce consumptive and depletive uses of water supplies.

- Develop training and educational program for municipal and county planning board and environmental commissioners on methods for using water capacity thresholds in Municipal Land Use decision making.

Rationale: RMP Implementation Strategies support the necessity to provide for the maximum feasible local government and public input into the Highlands Council's operations. Section 11.a.(3). The RMP is a “living document” and will continue to be refined and developed in support of regional planning goals. In order to facilitate regional planning goals it is imperative that the RMP have State, County, and local support from all levels of government and the support of the stakeholders of the Highlands Region.

II. REQUIREMENTS OF THE HIGHLANDS ACT AND RMP GOALS RELATED TO AVAILABLE WATER CAPACITY:

Findings of the Highlands Act:

The Highlands Act includes specific legislative findings relating to water availability:

The Legislature further finds and declares that the New Jersey Highlands is an **essential source of drinking water, providing clean and plentiful drinking water for one-half of the State's population**, including communities beyond the New Jersey Highlands, from only 13 percent of the State's land area; that the New Jersey Highlands contains other exceptional natural resources such as clean air, contiguous forest lands, wetlands, pristine watersheds, and habitat for fauna and flora, includes many sites of historic significance, and provides abundant recreational opportunities for the citizens of the State.” Section 2. (emphasis added).

“The Legislature further finds and declares that in the New Jersey Highlands there is a mountain ridge running southwest from Hamburg Mountain in Sussex County that separates the eastern and the western New Jersey Highlands; that **much of the State's drinking water supplies originate in the eastern New Jersey Highlands**; and that planning for the region and the environmental standards and regulations to protect those water supplies should be developed with regard to the differences in the topography of the Highlands Region and how the topography affects the quality of the water supplies.” Section 2. (emphasis added).

Goals of the Highlands Act: In accordance with Section 10.a of the Highlands Act, the overarching goal of the Regional Master Plan “with respect to the entire Highlands Region shall be to protect and enhance the significant values of the resources thereof in a manner which is consistent with the purposes and provisions of this act.”

Requirements of the Highlands Act:

Resource Assessment

The Highlands Act includes a goal to “protect, restore and enhance water quality and quantity of surface and ground waters.” Sections 10(b)1 and 10(c)1. The resource assessment component of the RMP must determine “the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values thereof, with special reference to surface and ground water quality and supply...” Section 11.a.(1)(a).

Smart Growth Component

The Highlands Act includes specific requirements relating to wastewater capacity, requiring the development of a Smart Growth component that includes “A smart growth component that includes an assessment, based upon the {the Resource Assessment}, of opportunities for appropriate development, redevelopment,

and economic growth, and a transfer of development rights program which shall include consideration of public investment priorities, infrastructure investments, economic development, revitalization, housing, transportation, energy resources, waste management, recycling, brownfields, and design such as mixed-use, compact design, and transit villages. In preparing this component, the council shall:

- (a) prepare a land use capability map;
- (b) identify existing developed areas capable of sustaining redevelopment activities and investment;
- (c) identify undeveloped areas in the planning area, which are not significantly constrained by environmental limitations such as steep slopes, wetlands, or dense forests, are not prime agricultural areas, and are located near or adjacent to existing development and infrastructure, that could be developed;
- (d) identify transportation, water, wastewater, and power infrastructure that would support or limit development and redevelopment in the planning area. This analysis shall also provide proposed densities for development, redevelopment, or voluntary receiving zones for the transfer of development rights; identify potential voluntary receiving zones in the planning area for the transfer of development rights through the appropriate expansion of infrastructure or the modified uses of existing infrastructure;
- (e) issue model minimum standards for municipal and county master planning and development regulations outside of the preservation area, including density standards for center-based development to encourage, where appropriate, the adoption of such standards;
- (f) identify special critical environmental areas and other critical natural resource lands where development should be limited; and
- (g) identify areas appropriate for redevelopment and set appropriate density standards for redevelopment. Any area identified for possible redevelopment pursuant to this subparagraph shall be either a brownfield site designated by the Department of Environmental Protection or a site at which at least 70% of the area thereof is covered with impervious surface.” Section 11.a.(6)(emphasis added).

As such, the Smart Growth component will be dependent upon and linked to the Resource Assessment, including the determination of available water.

Preservation Area Assessment

For the Preservation Area, Section 12 of the Highlands Act requires “a land use capability map and a comprehensive statement of policies for planning and managing the development and use of land in the preservation area, which shall be based upon, comply with, and implement the environmental standards” adopted by NJDEP and the Resource Assessment prepared the Highlands Council under Section 11.

Section 12 specifically requires implementation “that will ensure the continued, uniform, and consistent protection of the Highlands Region in accordance with the goals, purposes, policies, and provisions of this act, and shall include:

- a. a preservation zone element that identifies zones within the preservation area where development shall not occur in order to protect water resources and environmentally sensitive lands and which shall be permanently preserved through use of a variety of tools, including but not limited to land acquisition and the transfer of development rights; and
- b. minimum standards governing municipal and county master planning, development regulations, and other regulations concerning the development and use of land in the preservation area, including, but not limited to, standards for minimum lot sizes and stream setbacks, construction on steep slopes, maximum appropriate population densities, and regulated or prohibited uses for specific portions of the preservation area. Section 12.

Preservation Area Requirements

Section 34 of the Highlands Act requires the following:

“...any diversion of more than 50,000 gallons per day, and multiple diversions by the same or related entities for the same or related projects or developments of more than 50,000 gallons per day, of waters of the Highlands shall require a permit pursuant to the "Water Supply Management Act," P.L.1981, c.262

(C.58:1A-1 et seq.), and any permit issued pursuant thereto shall be based on consideration of individual and cumulative impacts of multiple diversions, maintenance of stream base flows, minimization of depletive use, maintenance of existing water quality, and protection of ecological uses. Any new or increased diversion for nonpotable purposes that is more than 50% consumptive shall require an equivalent reduction in water demand within the same subdrainage area through such means as groundwater recharge of stormwater or reuse. Existing unused allocation or allocations used for nonpotable purposes may be revoked by the department where measures to the maximum extent practicable are not implemented to reduce demand. All new or increased diversions shall be required to implement water conservation measures to the maximum extent practicable.”

In addition, Section 36 of the Highlands Act requires that NJDEP’s permitting review approval without a waiver may be issued only upon a finding that the proposed major Highlands development:

(1) would have a de minimis impact on water resources and would not cause or contribute to a significant degradation of surface or ground waters. In making this determination, the commissioner shall consider the extent of any impacts on water resources resulting from the proposed major Highlands development, including, but not limited to, the regenerative capacity of aquifers or other surface or ground water supplies, increases in stormwater generated, increases in impervious surface, increases in stormwater pollutant loading, changes in land use, and changes in vegetative cover;

(2) would cause minimal feasible interference with the natural functioning of animal, plant, and other natural resources at the site and within the surrounding area, and minimal feasible individual and cumulative adverse impacts to the environment both onsite and offsite of the major Highlands development;

(3) will result in minimum feasible alteration or impairment of the aquatic ecosystem including existing contour, vegetation, fish and wildlife resources, and aquatic circulation of a freshwater wetland;

(4) will not jeopardize the continued existence of species listed pursuant to "The Endangered and Nongame Species Conservation Act," P.L.1973, c. 309 (C.23:2A-1 et seq.) or the "Endangered Plant Species List Act," P.L.1989, c. 56 (C.13:1B-15.151 et seq.), or which appear on the federal endangered or threatened species list, and will not result in the likelihood of the destruction or adverse modification of habitat for any rare, threatened, or endangered species of animal or plant;

(5) is located or constructed so as to neither endanger human life or property nor otherwise impair the public health, safety, and welfare;

(6) would result in minimal practicable degradation of unique or irreplaceable land types, historical or archeological areas, and existing public scenic attributes at the site and within the surrounding area; and

(7) meets all other applicable department standards, rules, and regulations and State laws.” Section 36.

In addition, Section 73 requires that “[p]rior to the adoption of any revision to the New Jersey Statewide Water Supply Plan . . . the department shall consult with the Highlands Water Protection and Planning Council, established pursuant to section 4 of P.L.2004, c. 120 (C.13:20-4), concerning the possible effects and impact of the plan upon the Highlands regional master plan, adopted pursuant to section 8 of P.L.2004, c. 120 (C.13:20-8), and the water and other natural resources of the Highlands Region.”

Local Participation Component

A component to provide for the maximum feasible local government and public input into the council's operations, which shall include a framework for developing policies for the planning area in conjunction with those local government units in the planning area who choose to conform to the regional master plan. Section 11.a.(3).

Coordination and Consistency Component

A coordination and consistency component which details the ways in which local, State, and federal programs and policies may best be coordinated to promote the goals, purposes, policies, and provisions of the regional master plan, and which details how land, water, and structures managed by governmental or

nongovernmental entities in the public interest within the Highlands Region may be integrated into the regional master plan. Section 11.a.(4).

III. TECHNICAL BASIS AND JUSTIFICATION FOR STAFF RECOMMENDATIONS

The Highlands Act describes the concept of water availability generally as the amount of water supply that can be used to support human development and activity while maintaining Highlands ecological values: this concept is herein termed “water availability.” To meet the statutory requirement, it is necessary to define water availability in a manner that allows the Highlands Council to provide useful information to municipalities and other entities. The purpose of this element of the RMP is to:

- estimate the natural capacity of ground water resources throughout the Highlands Region,
- estimate the extent to which ground water resources must be reserved to sustain the aquatic ecosystem,
- determine the extent to which ground water resources, beyond those required to sustain aquatic ecosystems, should be reserved to maintain yields of existing public water supply systems,
- provide estimates of water resources available for human uses,
- determines areas where the use of water may have exceeded the ability of the resource to sustain that use, and
- identify appropriate management strategies that can help ameliorate such deficits.

Key issues include:

- defining the conditions by which water availability is estimated;
- determining the most appropriate geographic unit area for assessing water availability;
- determining whether and how water availability may be defined differently among the overlay zones of the Land Use Capability Map in the RMP; and
- determining how to compare the current uses of water to water availability so that areas of deficit and surplus may be identified.

The water resources element of the RMP estimates the amount of water necessary to protect the ecological integrity of Highlands waters, and that which is “available” for human uses such as potable water supply, industry or agriculture. The RMP then seeks to ensure that projected human needs do not diminish the availability of ground water that is critical for ecological maintenance and for existing water supplies, such as reservoirs.

Base flow is the amount of ground water seepage into a stream, and provides all of the natural stream flow during dry periods. Protection of base flow is critical to maintaining healthy aquatic ecosystems and protecting potable surface water supplies, particularly during periods of drought. Consumptive uses of ground water and surface water can reduce base flows during low flow periods, impair the ecological function and integrity of Highlands waters, and reduce the reliability of potable water supplies. Other stream flow parameters can also be critical to ecosystem integrity, such as higher flow pulses, flood flows, etc., but less information is available to address them at this time. Unfortunately, no method is currently available to the Highlands Council that provides a direct, causative and measurable relationship between aquatic ecosystem integrity and stream flows. For this reason, the Highlands Council focused on the severity and duration of low flows as a reasonable surrogate for ecosystem impacts.

The Highlands Council investigated a variety of low flow statistical methods to derive estimates of **Ground Water Capacity** to help inform policies regarding surface and ground water protection requirements and available water supply, which in turn are used to establish sustainable thresholds to growth within the Highlands Region. This approach is intended to meet the dual goals of protecting the ecological integrity of Highlands waters and defining and protecting water supply.

The Highlands Council worked in cooperation with the United States Geological Survey - New Jersey Water Science Center to develop appropriate methods to assess ground water capacity and availability in the Highlands Region. A technical memorandum titled Overview of Water Capacity Analysis Methods and Methods Comparison discussed the methods considered for incorporation into the RMP. The results of these evaluations were reported in a technical memorandum titled Low Flow Characteristics of Streams and Estimates of Ground Water Capacity.

It should be noted that there are always uncertainties in modeling processes, because no model can fully reflect reality and because data and methodology limitations always exist. The Highlands Council focused on providing a sound conceptual approach that can be augmented, updated or even replaced as better science and data become available. Key areas for research revolve around the known uncertainties in the process:

- Climate change – Scientific consensus has been developing in the last decade that the increase in greenhouse gases is and will be causing increases in global temperatures. The climatic impacts of these increases on a regional basis are less clear, and local impacts are even less clear. Models can be developed that assess the sensitivity of hydrologic systems to changes in rainfall patterns and densities, evaporation and transpiration rates, etc. Management approaches can be used to then ensure sustainability based on the most likely impacts.
- Gauging station accuracy – Stream monitoring stations are mechanical devices that are routinely checked for accuracy, but will always have a certain potential for inaccuracy based on the limitations of the technology and the gauging station sites. USGS considers records to be of “excellent” quality if 95% of daily measurements are within 5% of the true value. Models can address the sensitivity of results to the potential for measurement differences from true values.
- Data record limitations such as number of stations, stream types covered and length of record – There is a relatively limited number of stream monitoring stations in the Highlands. Very few of them monitor stream flows from very small drainage basins (e.g., those of first or second order streams) that might be more sensitive to the impacts of development, such as impervious surfaces or stormwater systems, or of localized water withdrawals. Length of record issues can only be solved by time, which makes the establishment of new monitoring stations in critical areas a very time-sensitive issue.
- Watershed and Land Use Changes – Reforestation has been noted in several areas of New Jersey, as previously farmed areas are allowed to regrow forest cover. This process can increase recharge. Deforestation also occurs, related to new development and (rarely) to new agricultural development, which can reduce recharge. The impervious and semi-pervious surfaces associated with development also modify both recharge and runoff patterns and quantities, although new regulations require retention of pre-construction recharge rates. Reduction in recharge can have a corresponding affect on base flow of streams and as such on the capacity of ground water systems. An improved understanding of this issue will allow for a more robust water availability modeling approach.
- Improved understanding of how each of these factors affects recharge, stream base flows and water availability are important.
- Conceptual model limitations regarding direct correlations between stream flows and aquatic ecosystem integrity – Considerable research is occurring on this issue nationally, and NJDEP is working with USGS to develop a model that addresses this issue in part, the NJ Hydroecological Assessment Tool. However, this tool is based on assumptions drawn from research regarding the link between flow statistics and ecological impacts. Other methods such as R2Cross and Wetted Perimeter which rely on in-stream conditions may also be useful in further refining estimates of water availability. More research is needed to develop a stronger link, and should include field research on actual stream ecosystem flow needs to establish better conceptual models and to “ground truth” what is developed.

- The potential variation of impacts within individual watersheds and subwatersheds based on water use and land use patterns – The analyses for water availability relied on the HUC14 subwatershed as the smallest “accounting unit” feasible at this time. However, water uses and water availability are not always uniform across the subwatershed. There are two methods to improve the analysis over time: developing smaller scale drainage areas using the upcoming LiDAR topography data; and better linkages between the source of water and the land areas where the water is actually used. Both should be pursued.
- Undocumented water uses – NJDEP regulates certain classes of water uses through the water allocation permit and agricultural water use programs, and has information on some smaller potable water uses through the safe drinking water program. However, information on other small water uses is limited, and methods need to be developed to update estimates of non-regulated water uses.
- The need for updated consumptive use assumptions by water use type – The USGS provided consumptive use estimates by water use type based on assumptions of consumptive use as a percentage of total use. Improved information on the actual consumptive use percentages will provide a more robust basis for both water availability and water conservation activities.

IV. GLOSSARY

Consumptive Use – That part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock or otherwise removed from the immediate water environment other than by transport through pipelines and other conveyances as potable water or wastewater.

Depletive Use – Those water uses that physically transfer water from one watershed to another through pipelines and other conveyances as potable water or wastewater, resulting in a loss of water to the originating watershed.

Ground Water Availability – As it relates to the development of the Highlands Regional Master Plan, ground water availability is defined as the rate of ground water use that can occur in an area without contravening the goals and objectives of the Highlands Act. It is that portion of the ground water capacity of a subwatershed that can be provided for human use without harm to other ground water users, aquatic ecosystems or downstream users. Net Ground Water Availability is Ground Water Availability minus the impact of the maximum month consumptive use for the target year (2003).

Ground Water Capacity – The natural ability of a subwatershed to support stream flow over time, during dry weather climatic conditions. It is based upon the Low Flow Margin component of the Low Flow Margin of Safety Method.

Hydrologic Unit Code – Hydrologic Unit Code (HUC) means an area within which water drains to a particular receiving surface-water body, which is identified by a specific digit number, or “hydrologic unit code.” The HUC codes were developed by the U.S. Geological Survey. *N.J.A.C. 7:38-1.4.*

HUC14 - An area within which water drains to a particular receiving surface-water body, which is identified by a fourteen-digit number, or “hydrologic unit code.” In New Jersey, a HUC14 correlates to a subwatershed. *N.J.A.C. 7:38-1.4.*

Low Flow Margin of Safety Method – This method is an ecologically-oriented approach for the purpose of defining ground water capacity based on a margin between two stream low flow statistics. The low flow statistic used traditionally in quantifying surface water safe yields is the lowest total flow over seven consecutive days during a ten-year period, the 7Q10. The 7Q10 is also often used to define an extreme low flow condition. A

critical flow regime for aquatic ecology is the lowest monthly flow, which in New Jersey and the Highlands Region tends to occur most years in September. The “Low Flow Margin” is the difference between the September median flow in a stream and the 7Q10 flow. The Low Flow Margin of Safety is the Low Flow Margin multiplied by a percentage based on the ecological sensitivity of the subwatershed, and is equivalent to total ground water availability.

Low Impact Development – Low Impact Development (LID) is an approach to land development that uses various land planning and design practices and technologies to simultaneously conserve and protect natural resource systems and reduce infrastructure costs. LID allows land to be developed, but in a cost-effective manner that helps mitigate potential environmental impacts.

Net Water Availability – The value resulting from subtracting the impacts of maximum consumptive water uses (both surface and ground water) from total ground water availability, as adjusted for depletive water uses and water imports. This value is then modified as needed to protect downstream potable water supply intakes and reservoirs for surface water supplies, and to protect downstream flows in subwatersheds with deficits in net water availability.

Passing Flow - The volume of water required by statute or NJDEP permit to be flowing past a specified point in a river or stream in a specified time - generally measured per hour or per day. Passing flows may be used to trigger cessation of withdrawals or releases from storage to augment flows.

Safe Yield - The annual amount of water that can be provided for human use from a source of supply over a repeat of the drought of record, reflecting passing flows requirements, demand patterns, watershed conditions and precipitation patterns.

Source Water Protection Area - The area contributing water flow to a potable water supply well or surface water intake used for a public water supply system, from which pollutants if present could move to the intake or well. A wellhead protection area is an example of an SWP area.

Water Availability Deficit Areas – Subwatersheds where Net Water Availability is less than zero.

Water Availability Constrained Areas – Subwatersheds that contribute flows to a Water Availability Deficit Area are considered Current Water Availability Constrained Areas. Subwatersheds where consumptive water uses at full allocation (based on NJDEP permits) exceed Net Ground Water Availability are considered Future Water Availability Constrained Areas.

V. REFERENCES

NJ Department of Environmental Protection. 1996. New Jersey Statewide Water Supply Plan.

NJ Highlands Council. 2006a. Revised 11 April 2006. “Overview of Water Capacity Analysis Methods and Methods Comparison”

NJ Highlands Council. 2006b. “Technical Memorandum – Low Flow Characteristics of Streams and Estimates of Ground-Water Capacity”

NJ Highlands Council. 2006c. “Technical Memorandum – Ecological Flow Goals: Hydroecological Integrity Assessment and Effects of Water Withdrawals in Four Gaged Stream Basins in the New Jersey Highlands Methodology and Results”