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National Toxicology Program Laboratory Board of Scientific Councilors Review
December 18-19, 2013

Section 1.0) Overview of the National Toxicology Program Laboratory (Author: Waalkes)

1.01) The History and Mission of the National Toxicology Program Laboratory

1.01a) History

The National Toxicology Program Laboratory (NTPL) was created as part of the organization of the National Institute of Environmental Health Sciences (NIEHS) portion of the National Toxicology Program (NTP) into a second intramural division. The Division of the National Toxicology Program (DNTP) was approved by the Secretary of Health and Human Services on February 22, 2011, and formally announced in April of 2011.

1.01b) Mission

The mission of the NTPL is to provide high quality laboratory capabilities and support for the performance of agent-specific, targeted research directly related to developing and applying tools of modern toxicology and molecular biology to the evaluation of specific substances of concern to the NTP, issues of central importance to the programs of the NTP, or the development of new methods to advance the scientific mission of the NTP. This includes being a programmatic "wet" laboratory within the DNTP, addressing toxic mechanisms, acquiring, producing and/or refining the development of DNTP-relevant methods, and studying cross-cutting issues of interest to DNTP. One cross-cutting issue that was specifically identified as a research focus upon the inception of the NTPL was the study of the developmental origins of adult disease.

1.02) Organization of NTPL

The NTPL is organized into the NTPL Office of the Laboratory Chief and five Groups based on scientific expertise (**Figure 1, next page**). They include:

1.02a) NTPL Office of the Laboratory Chief (OC)

1) Staff: Michael P. Waalkes, Ph.D. is the Chief of the NTPL. Sally Fields, an Intramural Program Specialist, is the primary administrative support staff, and Anna Lee Mosley, a contractor, was detailed from the DNTP Office of the Division Director to assist with preparation of materials for the NTPL review.

2) Responsibilities: The Laboratory Chief oversees the general operations of the NTPL, interacts on behalf of the Laboratory with the Division, communicates important information from DNTP Director and DNTP Leadership to the NTPL Group Leaders or other personnel, tracks Group budgets, aids in development of NTPL projects, assigns tasks or portions of tasks to NTPL members as needed for projects that are assigned to NTPL, and ensures laboratory safety regulations are followed. The Chief also reviews

relevant permanent Government personnel for performance as required generally at the Group Leader level.

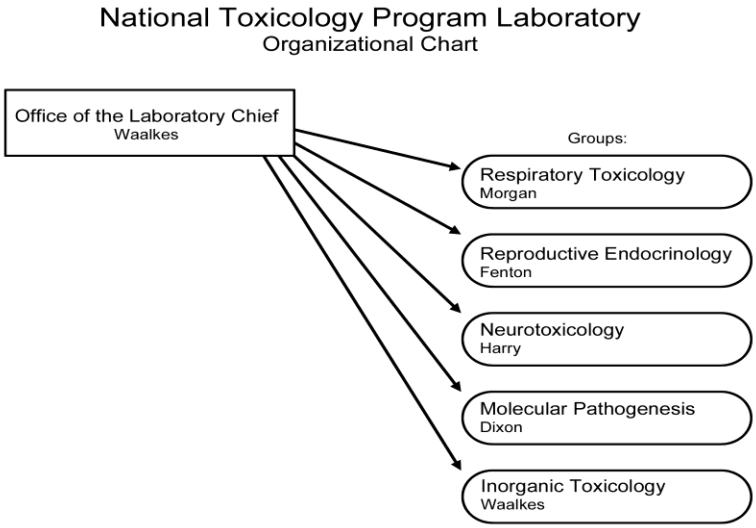

Figure 1: NTPL Organizational Chart showing all the various Groups and Group leaders.

The OC support staff provides logistical support for day-to-day operations of the various Groups. This includes any personnel detailed to the NTPL or temporarily working within the NTPL. Within the OC, Sally Fields processes purchase requests for the Laboratory Chief's approval, processes travel orders for approval and voucher, constructs personnel actions for approval, and coordinates NTPL monthly reports for transmittal to the DNTP Director Division for submission to NIEHS Leadership. Upon request of the Laboratory Chief, Mrs. Fields tracks and updates the Group budget allocations for dispersal to the Group Leaders, and works closely with the Administrative Management Branch's Administrative Officers to implement any updates and procedural changes to travel, purchasing, etc., required in order to maintain current optimal work flow in the OC and NTPL. These updates frequently require additional training usually held at NIEHS.

The OC provides a point of contact for the coordination of modifications or updates to the NTPL website. The OC also coordinates yearly capital property inventory for NIEHS, which is carried out by specific property managers within the individual NTPL Groups.

1.02b) Specific NTPL Groups and Personnel

1) The Inorganic Toxicology Group led by Dr. Waalkes. Permanent staff includes Wei Qu, M.D., Ph.D. (Biologist), and Erik Tokar, Ph.D. (Biologist). Current Postdoctoral staff within the Inorganic Toxicology Group include Rachel Person, Ph.D. (Intramural Research Training Associate [IRTA]), Ntube N. O. Ngalame, Ph.D. (Visiting Fellow [VF]), and Yuanyuan Xu, Ph.D. (VF). The Inorganic Toxicology Group is supported by technician Matthew Bell, B.A. (contractor). Katherine Pelch, Ph.D. (IRTA) is attached to the Inorganic Toxicology Group from the Office of Health Assessment and Translation, DNTP and will perform functions with both groups during her tenure.

2) The Molecular Pathogenesis Group is led by Darlene Dixon, D.V.M., Ph.D., D.A.C.V.P., and includes as permanent staff Lysandra Castro, B.S. (Biologist), Xianhong Yu, M.D., M.S. (Biologist), Alicia Moore, M.S. (Biologist), and Postdoctoral staff Xiaohua Gao, M.D., Ph.D. (Research Fellow).

3) The Neurotoxicology Group is led by G. Jean Harry, Ph.D., and includes as permanent staff Christopher McPherson, Ph.D. (Biologist), and as Postdoctoral staff Ruben G. Orihuela Garcia, Ph.D. (VF).

4) The Reproductive Endocrinology Group is led by Suzanne Fenton, Ph.D. and includes permanent staff Jason Stanko, Ph.D. (Biologist) and Predoctoral staff Madisa Macon, M.P.H. (Predoctoral IRTA), Adam Filgo (Predoctoral IRTA), Deirdre Robinson (Predoctoral IRTA). Support staff includes Vesna Chappell, Ph.D. (Contractor) and Casey Reed (B.A., Contractor; part-time). Erin Quist, D.V.M., M.S., D.A.C.V.P., is a Predoctoral IRTA in the Reproductive Endocrinology Group and a Toxicologic Pathology Fellow in the DNTP Cellular and Molecular Pathology Branch (salary source).

5) The Respiratory Toxicology Group is led by Daniel Morgan, Ph.D., and includes permanent staff William Gwinn, Ph.D. (Staff Scientist) and Cassandra Shines, M.S. (Biologist). Dr. Morgan also oversees the Alion contract that has rodent inhalation capacity (Section 7 for details).

1.03) Overview of NTPL's Role in Support of the Mission of the NIEHS

1.03a) Rationale for Creation of NTPL

1) As the DNTP moves forward into the 21st century it has been tasked to place increased emphasis on studies that help define critical cellular and molecular events that lead to adverse responses to toxicants. This emphasis is to help guide the interpretation and integration of data on toxicological mechanisms with findings from more traditional safety assessment studies to strengthen the scientific base of public health decision-making. This places increased emphasis on studies that will define key events in toxic mechanisms or critical pathways in responses to toxicants. NTPL was conceived in part to provide assistance to DNTP with these tasks.

1.03b) Specific Mission Elements

1) A major mission element of the NTPL is to provide DNTP with a state-of-the-art toxicology and molecular biology laboratory for research.

2) The provision of high quality research capabilities via NTPL in support of DNTP allows:

   a) The performance of agent-specific targeted research *in vivo* or *in vitro* related to developing and applying tools of modern toxicology and molecular biology to evaluating specific substances of concern to DNTP.

   b) The performance of research, including elucidation of mechanisms, on issues of central or crosscutting importance to the mission of DNTP. One crosscutting issue to DNTP that was placed within the purview of NTPL from its inception is the study of the developmental origins of adult disease. Within the NTPL this includes development of models and investigations of mechanisms to explain how

exposure to environmental substances in early life exposure can cause disease in adulthood.

c) The acquisition, development and/or refinement of new or existing methods to advance the DNTP mission. The NTPL has multiple successful examples of methods development or acquisition that are outlined within the specific Group reports. Examples of such methods include improved techniques for histopathology of uterine and breast lesions, application of novel molecular biological methods to DNTP studies, *in vitro* stem cell methodology, refinement of neurobehavioral methodology, *in vitro* assessment of metallic particle dissolution by macrophages, etc.

1.03c) Critical Functions of the NTPL

1) NTPL functions as a core laboratory facility for all of DNTP. It takes on laboratory research tasks as assigned based on relevant Group expertise and workload as determined by the NTPL Chief. NTPL designs and carries out studies with appropriate approval based on study concepts passed on by NIEHS/DNTP leadership or other formal channels.

2) NTPL functions to design and conduct internal research on various topics of concern to DNTP. It designs and carries out studies with appropriate approval based on Group expertise and NTPL Mission.

3) NTPL provides a rapid response team for immediate research needs for the rest of NIEHS/DNTP ("Firefighter" missions). Mobilization of NTPL resources in this case are based on emergency issue or issues as identified by Division or Institute Leadership for rapid response within an area of NTPL capabilities and expertise. These issues are recognized as rare occurrences.

4) NTPL provides wet laboratory space for training and/or use of non-NTPL DNTP staff. The NTPL has permanent staff that has been assigned to specific groups and works on expertise relevant tasks as generated by various sources within DNTP, including NTPL itself. However, NTPL also maintains a unique capacity of being able to host non-NTPL staff from other DNTP branches or offices to participate in a particular study, or learn or develop a critical method, etc. The goal is to provide temporary laboratory space for specific research, methods development or for training needs for staff from other parts of DNTP. To this end, laboratory space has been reserved and is allotted by the OC and allows NTPL the flexibility to temporally house such guest workers.

1.03d) Scope and Nature of NTPL Capabilities

1) NTPL performs studies of various types and develops methods as needed. To accomplish this, the NTPL is expected to continually update our expertise. In some cases, we have drawn on outside expertise from other groups within DNTP to fill critical gaps. NTPL studies may be flexible in nature such that research direction or approaches may change based on intermediate findings. Some NTPL work has required outside contract support,

but this has generally been modest. The scope of expertise within the NTPL influences, but does not dictate, the nature and scope of NTPL studies.

2) Currently NTPL has expertise in the areas of: inhalation toxicology, reproductive toxicology, chemical carcinogenesis, developmental basis of adult disease, *in vitro* cell model systems of disease, neurotoxicology, pathology, stem/progenitor cells, pulmonary function, neurobehavior, reproductive tract carcinogenesis, mammary toxicology and genomic/phenotypic relationships, and toxicokinetics in the maternal/fetal unit.

3) Currently the NTPL has expertise and interest in studies of the following classes of toxicants: gases, vapors, inorganics, endocrine disruptors, inhaled particulates, organic volatiles, perfluorinated compounds, phytoestrogens, endogenous hormones, brominated flame retardants, persistent organic pollutants, chlorotriazine herbicides and metabolites.

1.04) Types of Studies Performed by NTPL

The NTPL is intended to perform primarily, but not exclusively, in-house, generally small sized, hypothesis or issue driven, often toxicant-relevant research for the DNTP. Potential studies, for instance, can take the form of short- to intermediate-term rodent assays focused on pathological analysis of key target tissues, fresh isolation and culture of cells from treated rodents for purposes of critical early event analyses, studies using *in vitro* cellular models mimicking disease states, analysis of toxicant effects at the molecular level, or studies that combine rodent and cellular work. Study design is highly individualized and wide-ranging depending on the issue presented to the group. General types of research endeavors include:

1) Data augmentation: Performance of agent-specific, targeted research directly related to specific substances nominated to the DNTP. Such studies often augment already available DNTP data and take the form of research driven by a specific hypothesis or question on a previously nominated chemical toxicant. Depending on the study, NTPL has a large compliment of *in vivo* and *in vitro* methods to draw upon to formulate such study designs.

2) Central issues: The NTPL investigates issues deemed of central importance to programs of the DNTP by the DNTP leadership. These studies may be driven by broader, questions concerning multiple DNTP studies or multiple portions of the DNTP. Similarly, NTPL has a large compliment of *in vivo* and *in vitro* methods to draw upon on to formulate such study designs.

3) Develop/improve methods: The NTPL develops new methods to specifically advance the scientific programs and goals of the DNTP. These studies are intended to directly interface with, and become an integral part of, other portions of the DNTP. This kind of effort takes the form of specific, focused projects with a clear mission and end-point of eventual utilization of the developed method by other DNTP units.

4) Study design teams: NTPL personnel act as part of DNTP study design teams with the purpose of advisement or eventual performance of NTPL expertise relevant tasks within

the study. Tasks performed in such studies are varied but can include application of any scientific expertise within the NTPL. Examples would include molecular biological techniques, metals analyses, advanced *in vitro* techniques, inhalation toxicology, endocrine toxicology, molecular pathology, stem cell toxicology, and neurotoxicology. NTPL input has already contributed to various DNTP studies (see Section 7).

5) Host special projects: The NTPL provides temporary space to persons from other DNTP units to perform training or other specific, approved projects in accordance NTPL mission. These can be multi-year projects, as in post-doctoral training, or more specific as in a methods development effort. The projects are defined and approved via appropriate processes. The number of persons is limited by space available.

6) Emerging critical issues: The NTPL also provides a rapid response team for immediate DNTP laboratory research needs. The clear time-sensitive nature of this study type limits it to a strait-forward question and corresponding design. Resources are mobilized as needed by the NTPL for rapid response issues.

1.05) Processes for NTPL Study Generation

1.05a) General Concepts

NTPL project proposals may originate from anywhere within the DNTP. Proposed projects external to the NTPL are first tentatively approved by their Branch Chief of origin. NTPL projects generated internally follow the same process. Tentatively approved project concepts are assigned to the NTPL Chief for assignment within the NTPL, regardless of their point of origin, before any additional internal action. Further project development external to the NTPL will be done in coordination with NTPL staff as assigned by the NTPL Chief. Both internally and externally developed project concepts will involve selection of a study design team to prepare for project concept approval. The NTPL Chief assigns NTPL staff responsibility for development of projects, and a study design team leader is assigned to coordinate the project development.

1.05b) Specific Modes of Study Generation

1) Those assigned by NIEHS/DNTP leadership: Proposed NTPL project can come directly to the NTPL Chief from senior DNTP Leadership (DNTP Director, DNTP Deputy Directors).

2) NTPL activities or protocols can be performed after protocol approval conceived by internal or external DNTP scientists. Large projects have come to NTPL after consideration and approval by the Protocol Review Committee or, if smaller, or without a requirement for any experimental animals have been approved after review by the Nominations Discussion Group.

3) Several activities in NTPL are continuations of topic areas that were under study at the time of organization of the NTPL. All groups had expertise relevant research activities that were deemed of current interest to DNTP and hence were given approval to continue

to a logical conclusion. One activity that was specifically included was the study of the developmental origins of adult disease. Other, group-relevant, activities are detailed in the specific group write-ups.

1.06) Project Prioritization

The NTPL Chief prioritizes projects through coordination with the Division Director and DNTP Leadership. Periodic re-evaluation of the priority of projects is carried out. Projects that face long delays because of resource issues, lack of expertise, etc., may need to be re-directed or cancelled.

1.07) Project Funding

The NTPL has a centralized core budget overseen through the OC such that the Chief approves all purchases. This is because the work of the NTPL is dictated by DNTP projects rather than by individual investigator research initiatives. A Division of Intramural Research funding model dictates modest group-based bench worker allotments of research funds, which are generally insufficient for all but very small projects. The study design team estimates the various budgetary costs involved for approved NTPL projects prior to onset of the study. The estimate is presented to the DNTP Director via the NTPL Chief and appropriate funds can be channeled as required to the laboratory's budget for that study. The study design or group leader is responsible for tracking budget use and requesting and justifying any additional funding via the NTPL Chief as needed.

1.08) Location of NTPL Facilities

1.08a)

The NTPL primarily occupies laboratory and office space in on the NIEHS main campus in Building 101, on the first flood of Module E. The research Groups with laboratories located in E-1 includes the Inorganic Toxicology Group (Waalkes), the Molecular Pathogenesis Group (Dixon), the Neurotoxicology Group (Harry) and the Reproductive Endocrinology Group (Fenton) (**Figure 2; next page**). All of these groups have office space for group leaders in E-1 with the exception of the Molecular Pathogenesis Group where the Group leader has office space on Module B-3 and a member of this group with special needs is similarly located on B-3 to accommodate these needs (**Figure 3, next page**). The OC Support Staff office is located on B-3 in order to be closer to other specialists and administrative officers. The Reproductive Endocrinology Group also has some staff members with office space on B3.

1.08b)

The Respiratory Toxicology Group (Morgan) is located at the Alion Inhalation Complex, 5 Triangle Drive, Research Triangle Park, NC about 3.5 miles from NIEHS (**Figure 4**; **next page)**. The Group has laboratory and office space within this complex.

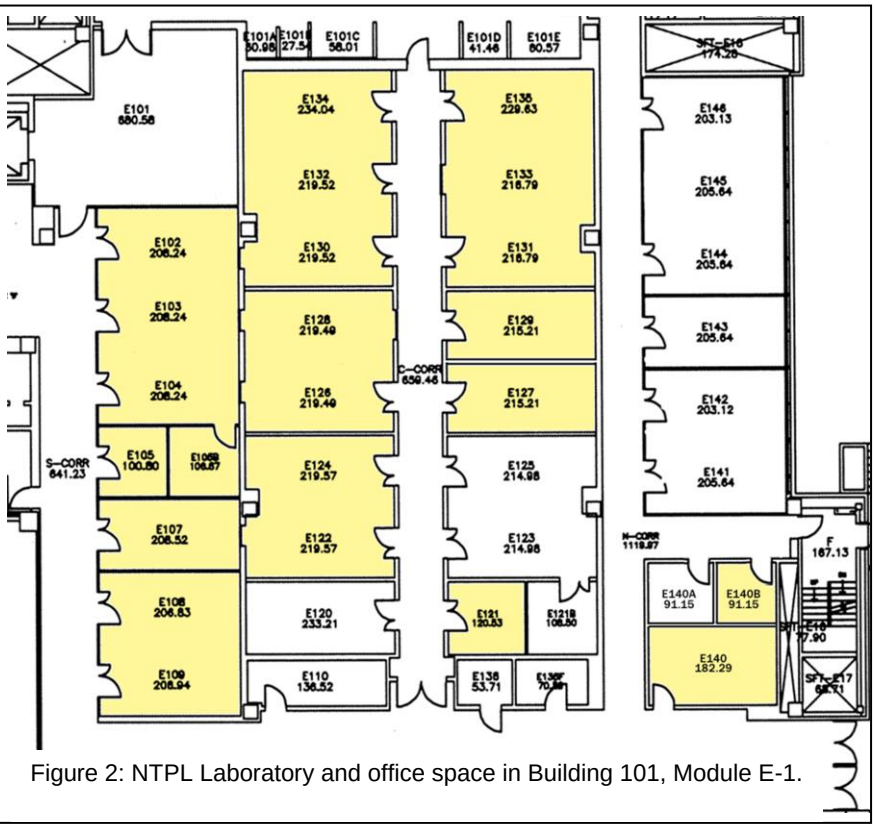

Figure 2: NTPL Laboratory and office space in Building 101, Module E-1.

1.09) NTPL Exceptional and Mission-Relevant Capabilities and Techniques

1.09a)

A variety of exceptional and DNTP mission-relevant capabilities, techniques and equipment make the members of NTPL well suited for an array of varied and complicated studies on various levels of biologic complexity. Tasked studies can range from the whole organism to strictly molecular in nature. Details of how these capabilities and techniques have been used so far are found in the individual sectional write-ups.

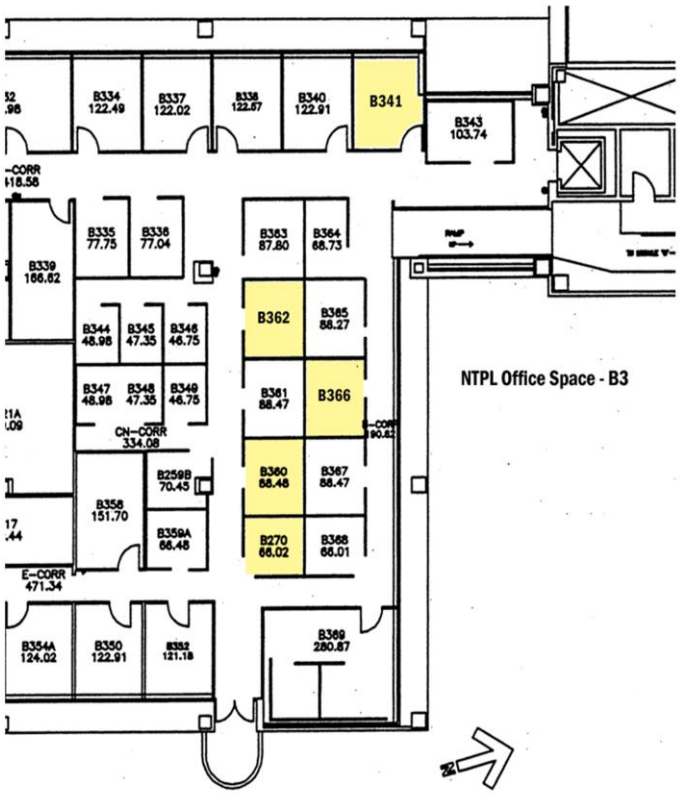

Figure 3: Office Space in Building 101 Module B, Floor 3

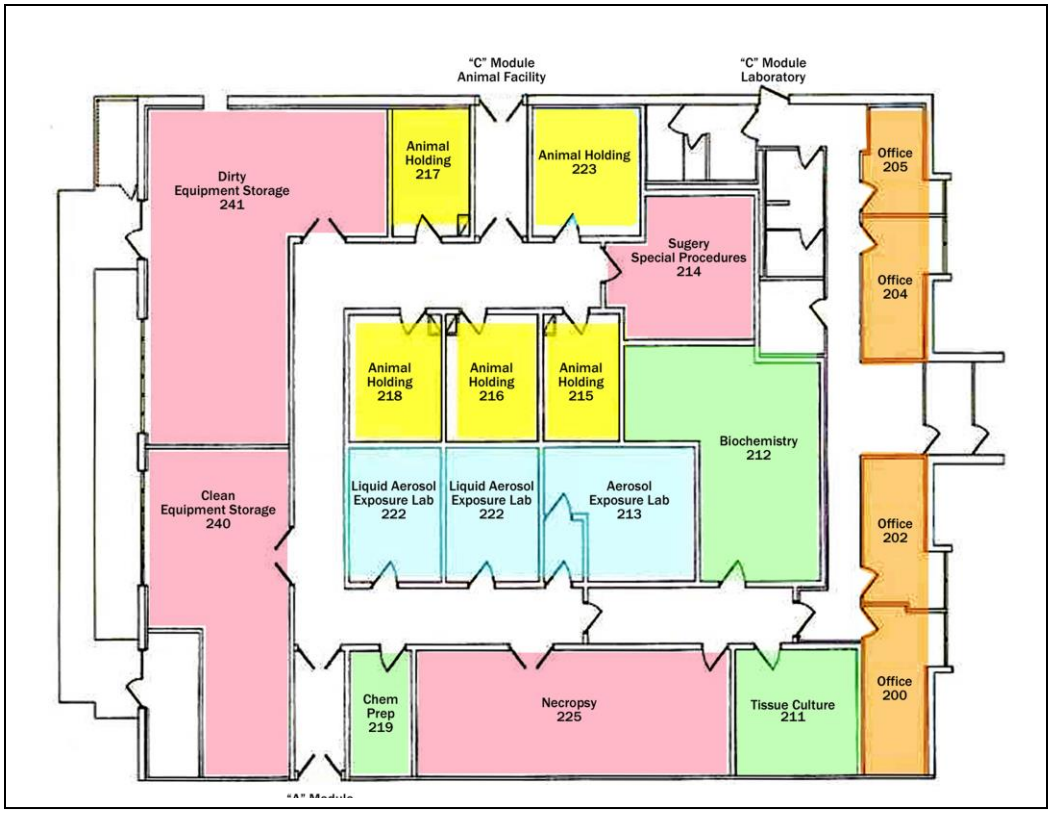

Figure 4: Module B of Alion Facility showing various animal housing and inhalation rooms as well as NTPL office and laboratory space. A and C modules are also used.

1.09b)

Examples of Exceptional and Mission-Related Capabilities:

1) Full range of all organ pathology/necropsy and molecular pathology techniques including immunohistochemical staining and evaluation/quantitation using morphometric analysis or scoring methodologies (Molecular Pathogenesis).

2) Inhalation exposure capabilities (whole body and nose only) and assessment of pulmonary function (flexivent, Buxco) (Respiratory Toxicology).

3) Animal housing and maintenance (short term) including animal dosing (all routes), conducting necropsies, tissue and blood collection for both inhalation and non-inhalation studies (Respiratory Toxicology/Alion).

4) Specific expertise in morphometric analyses of breast and uterine lesions in rodents (Reproductive Endocrinology and Molecular Pathogenesis).

5) Methods in endocrine toxicology (i.e. estrous cycle evaluation, ovariectomy, uterotrophic assay, lactation and puberty timing assessments, hormone assays, receptor analyses, chemical disposition in dam/fetus, etc.) (Reproductive Endocrinology).

6) Expertise in a wide range of basic and advanced molecular biology techniques (various groups).

7) Expertise in metals analyses (Inorganic Carcinogenesis).

8) Stem cell identification, isolation and culture, and activity assessment via transplant, including cancer stem cells (Inorganic Toxicology; Neurotoxicology; Reproductive Endocrinology).

9) Expertise in developmental neurobehavioral assessment (Neurotoxicology).

10) Expertise in primary and cell line tissue culture (various Groups).

11) Skill in assessment of mitochondria bioenergetics (Neurotoxicology).

12) Advanced knowledge in usage of various microscopes (e.g. real time fluorescent; fluorescent; Image Express, etc.; various Groups).

13) Expertise in animal mating and husbandry (Reproductive Endocrinology).

14) Skill in assessment of malignant cell transformation *in vitro* (Inorganic Toxicology).

15) Expertise in live cell imaging and high content fluorescent imaging (Neurotoxicology).

1.10) Significant Awards, Honors and Other Scholarly Activities of NTPL Group Leaders

1.10a) Recent Awards and Honors (Last Six Years)

1) Dixon: National Institutes of Health (NIH) Award of Merit (2009) for "Significant Pathology Contributions to the NTP and Division of Intramural Research Testing and Research Programs"; NIEHS Certificate of Appreciation (2013) for "Outstanding contribution as a NIEHS Scholars Connect Program Research Mentor"; Inducted as a Fellow into the International Academy of Toxicologic Pathology (2012). Elected Chair of the Society of Toxicologic Pathologists (STP) Reproductive Pathology Special Interest Group (2011-2012); Appointed by STP to Chair Organ Working Group on International Harmonization of Nomenclature and Diagnostic Criteria for the Female Reproductive Tract (2009-Present). Co-Chair, Co-organizer and NTP Host of "STP Workshop on Pathology Endpoints in Endocrine Disruptor Screening: The Pubertal Development and Thyroid Function Assay," (NIEHS, NTP, 2013); Co-organizer and Host of "HESI Workshop on Developing Guidance for Alternatives Assessment" (NIEHS, 2013); Co-organizer of "Advances in Uterine Leiomyoma Research: 3rd NIH International Congress," Bethesda, Maryland (2010).

2) Fenton: US Environmental Protection Agency (EPA) Scientific and Technological Achievement Award (STAA) Level III (2007) for published low dose adverse effects of female rat mammary glands following prenatal exposure to atrazine metabolites; US EPA

Level I STAA (2008) for a paper contributing to the understanding of early-life health effects following perinatal exposure to PFOA in mice; Elected Councilor for Reproductive and Developmental Toxicology Specialty Section of Society of Toxicology (2007-2009); ILSI HESI (International Life Sciences Institute, Health and Environmental Sciences Institute) Scientific Advisor award (2010) for leadership and scientific contributions to the Developmental and Reproductive Toxicology Technical Committee; NIH Merit Award (2010) for "Successfully leading validation efforts for mammary whole mount evaluations in NTP/NIEHS studies"; EPA STAA Level III Award (2010) for Hines et al. Method Development to Measure Phthalate Monoesters, Perfluorinated Chemicals and Endogenous Compounds in Human Milk; NIEHS Paper of the Year (Stanko et al., 2010); NIEHS Paper of the Year (Macon et al., 2011); EPA STAA Level III Award (2012) for Kodavanti et al. Research to Understand Developmental and Long-Term Consequences of Polybrominated Diphenyl Ether Exposures; Interagency Breast Cancer and Environment Coordinating Committee Award (2013) for "Outstanding participation and service to the Interagency Breast Cancer and Environment Coordinating Committee."

3) Harry: US EPA National Honor Award Gold Medal for exemplary service, Perchlorate Risk Characterization (2007); Lubomir S. Hnilica Memorial Lectureship, Vanderbilt University, Center for Toxicology, Nashville, TN (2011); Elected Counselor, Neurotoxicity Society (2005–2009); Elected Counselor, American Society for Neurochemistry (2011-2013).

4) Waalkes: Career Achievement Award, Metals Specialty Section, Society of Toxicology (2007); Promotion to Senior Biomedical Research Service (2008); NIEHS Paper of the Year (Tokar et al., 2010); Elected Councilor, Society of Toxicology (2010-2013); Special Award for Ten Years of Exemplary Service as Editor-in-Chief of *Toxicology and Applied Pharmacology* (2010); Two NIEHS Papers of the Year (Tokar et al., 2011a, b); Elected as a Fellow of the Academy of Toxicological Sciences (2012); NIEHS Special Act Award (2013) for high impact publication (Xu et al., 2012); NIEHS Special Merit Group Award (2013) for efforts in developing DNTP portion of Institute 2013-2017 Strategic Plan.

1.10b) Scholarly Activities: Academic Positions

1) Dixon: Adjunct Associate Professor, Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh (1999-present); Adjunct Professor, Department of Physiological Sciences, Division of Biochemistry, Eastern Virginia Medical School, Norfolk, Virginia (2008-present).

2) Fenton: Adjunct Associate Professor, Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh (2013-present); Adjunct Graduate Faculty, Curriculum in Toxicology (2005-Present), School of Medicine, University of North Carolina-Chapel Hill; Adjunct Graduate Faculty, Dept of Environmental Sciences and Engineering, (2003-Present), School of Public Health,

University of North Carolina-Chapel Hill; Adjunct Graduate Faculty (2003-Present), Departments of Biology and Chemistry, North Carolina Central University.

3) Harry: Faculty Affiliate, Curriculum in Toxicology (1992-present), School of Medicine, University of North Carolina-Chapel Hill; Faculty Affiliate, Biological and Biomedical Sciences Program (2007-present), University of North Carolina-Chapel Hill; Adjunct Associate Professor (1995-present), Integrated Toxicology Program, Duke University; Visiting Professor (2006-2009), Neurobiology Curriculum, University of North Carolina-Chapel Hill; Visiting Professor (1994 - 1997), Environmental Toxicology Program, New York University.

4) Waalkes: Adjunct Professor of Molecular Toxicology (2006-2010), Nicholas School of the Environment, Duke University; Adjunct Professor of Toxicology (1989- 2000), Environmental Toxicology Program, University of Maryland.

1.10c) Scholarly Activities; Editorial Boards

1) Dixon: *Toxicologic Pathology*, Editorial Board (2011-present); *Veterinary Pathology*, Editorial Board (2009-present); *Environmental Health Perspectives*, Editorial Board (1994-1997).

2) Fenton: *Birth Defects Research B*, Editorial Board (2003-present); *Reproductive Toxicology*, Editorial Board (2011-present); *Endocrine Disruptors*, Editorial Board (2013-present).

3) Harry: *Neurotoxicity Research*, Editorial Board (2013-present); *Neurotoxicology*, Associate Editor (2004-present).

4) Morgan: *Toxicology In Vitro*, Editorial Board (2004-present).

5) Waalkes: *Toxicology and Applied Pharmacology*: Editor-in-Chief (2000-2010), Associate Editor (1997-2000); *Environmental Health Perspectives*: Associate Editor (2009-present), Deputy Editor (2007-2008); *Chemical Research in Toxicology*, Editorial Board (2009-present); *Toxicology*, Editorial Board (1991-present); *Journal of Toxicology and Environmental Health*, Editorial Board (1992-present); *Toxic Substance Mechanisms*, Editorial Board (1992-2002); *Toxicology Mechanisms and Methods*, Editorial Board (2002-present). *Faculty of 1000* in Molecular Toxicology, Metals Toxicology, and Environmental Carcinogenesis (2012-present).

1.11) List of Abbreviations and Acronyms

DNTP	Division of the National Toxicology Program
EPA	Environmental Protection Agency
ILSI HESI	International Life Sciences Institute, Health and Environmental Sciences Institute
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NTP	National Toxicology Program
NTPL	National Toxicology Program Laboratory
OC	Office of the Laboratory Chief
SOT	Society of Toxicology
STAA	Scientific and Technological Achievement Award
STP	Society of Toxicologic Pathologists
VF	Visiting Fellow